SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 17.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 17.

NEW-YORK, APRIL 22, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

THE GRAMME MAGNETO-ELECTRIC MACHINE.

M. Tresca has recently communicated an interesting paper to the Academy of Sciences, containing the account of a series of experiments made in the establishment of MM. Sautter and Lemonnier, to ascertain the amount of work performed by the Gramme magneto-electric machine, employed for the production of light. For the account of these experiments, as well as for the engraving of the machine, we are indebted, says *Engineering*, to our contemporary, the *Revue Industrielle*.

It has long been desired to ascertain by direct experiment the amount of work expended in the production of the intense light obtained by the aid of the magneto-electric machine. An experiment made a considerable time ago at the Invalides on an Alliance machine, only supplied imperfect data, and it is interesting to check this report with the results furnished by the new Gramme machine. With this object, a dynamometer was set up in the works of MM. Sautter & Lemonnier, but experiments were only commenced on the 16th of October last on the great light-giving machine, which the inventor considers to be the best model he has produced. The results obtained on this occasion with a light equal to 1850 Carcel burners, led to further experiments on the 4th of December with a machine of 3000 burners.

The high speed at which the Gramme machine is driven, rendered it difficult to employ a dynamometer which should not make more than 250 revolutions per minute. However, the diagrams obtained were perfectly satisfactory after some preliminary trials. The work done has thus been accurately determined, but this was not the case with the luminous intensity. This latter was measured direct by a photometer with two discs, one illuminated solely by a Carcel lamp and the other by the electric lamp. One of these discs appeared of a green hue in relation to the other, which was rose-tinted, and amongst the various methods tried, it was found decidedly the best to correct the difference of these tints by the interposition of two Carcel lamps, burning 1.48 oz. per hour, and at a suitable distance from the photometer, the electric light being placed at a distance of 131.23 ft. in the first and 65.61 ft. in the second trial.

In spite of the uniformity of the electric current supplied to the regulator, the light, on account of the irregularity in the nature of the carbons, showed oscillations, which for the most part were perceptible only in the photometric determinations; but on this account a great difficulty arose in determining exactly the intensity and its definition in relation to the expenditure of power.

It was only possible to avoid these drawbacks by increasing the number of trials, and limiting their duration to very short periods. The standard lamp having been placed in such a position as to balance the average intensity of the electric light, the apparatus was kept at work during a certain time, and at the instant that an apparent equality was observed, a signal was given to the experimenter stationed at the dynamometer, and a diagram comprising a period of a few seconds was obtained. Another observer recorded the speed of the dynamometer per minute, and the dynamometer diagram was renewed only at a fresh signal from the operator at the photometer. The following tables give all the data obtained from the successful experiments thus conducted.

In order to ascertain the number of revolutions of the main shaft of the magneto-electric machine, it was necessary to make certain that there was no slipping of the driving belt. By means of various experiments, the speed of the two shafts was tested by means of two counters, and it was thus found, in the first trial, that the actual ratio of the speed was 5.18, the ratio calculated from the diameters of the pulleys, and the thickness of belts being 5.26. The speed of the Gramme machine shaft was thus found by multiplying the mean speed of the dynamometer shaft by 5.22, which gave for the first series of trials 1264 turns per minute; in the second series, the ratio of speeds being only 3.65 and the mean speed of the dynamometer 239 turns per minute, the number of revolutions of the machine was 239 + 3.65 = 872. The apparatus, which gave a light of 1850 Carcel lamps, and which is illustrated on the present page to a scale of one-fifth, is arranged as follows: The horizontal shaft carries two series of conductors placed symmetrically, the one on the left receiving the current from 15 bobbins spaced around a soft iron ring. In the intervals between these are 15 other bobbins in connection with the conductor placed on the other side of the shaft. The two currents combine when the bobbins turn around the shaft in front of the poles of the four electro-magnets, put in operation by a portion of the current, the balance being led off to the electric lamp. The following are the leading dimensions of the machine:

ELECTRO-MAGNETS.

Diameter of the electro-magnet..........	2.75 in.
Length " " "	15.90 "
Diameter of coil..........	5.19 "
Diameter of wire..........	.0125 "
Weight of copper rolled around each electro-magnet..........	52.8 lb.

BOBBINS.

Outside diameter of soft iron ring..........	7.67 in.
Inside " " " "	6.18 "
Width of soft iron ring..........	4.68 "
Outer diameter of bobbin..........	9.05 "
Inner " " "	4.72 "
Diameter of wire..........	.01 "
Total weight of wire..........	508 lb.
Diameter of conducting cylinders..........	3.54 in.
" " lamp wire..........	.03 "

MACHINE.

Total length, including pulley..........	31.5 in.
" height..........	23.03 "
" width..........	21.65 "

The machine giving a light of 3000 Carcel lamps is more simple, as it has only a single series of conductors and small bobbins and two electro-magnets only. The following are its leading dimensions:

ELECTRO-MAGNETS.

Diameter..........	2.75 in.
Length..........	13.97 "
Diameter of coil..........	4.72 "
" " wire..........	0.15 "
Weight of copper around each electro-magnet..........	31.5 lb.

BOBBINS.

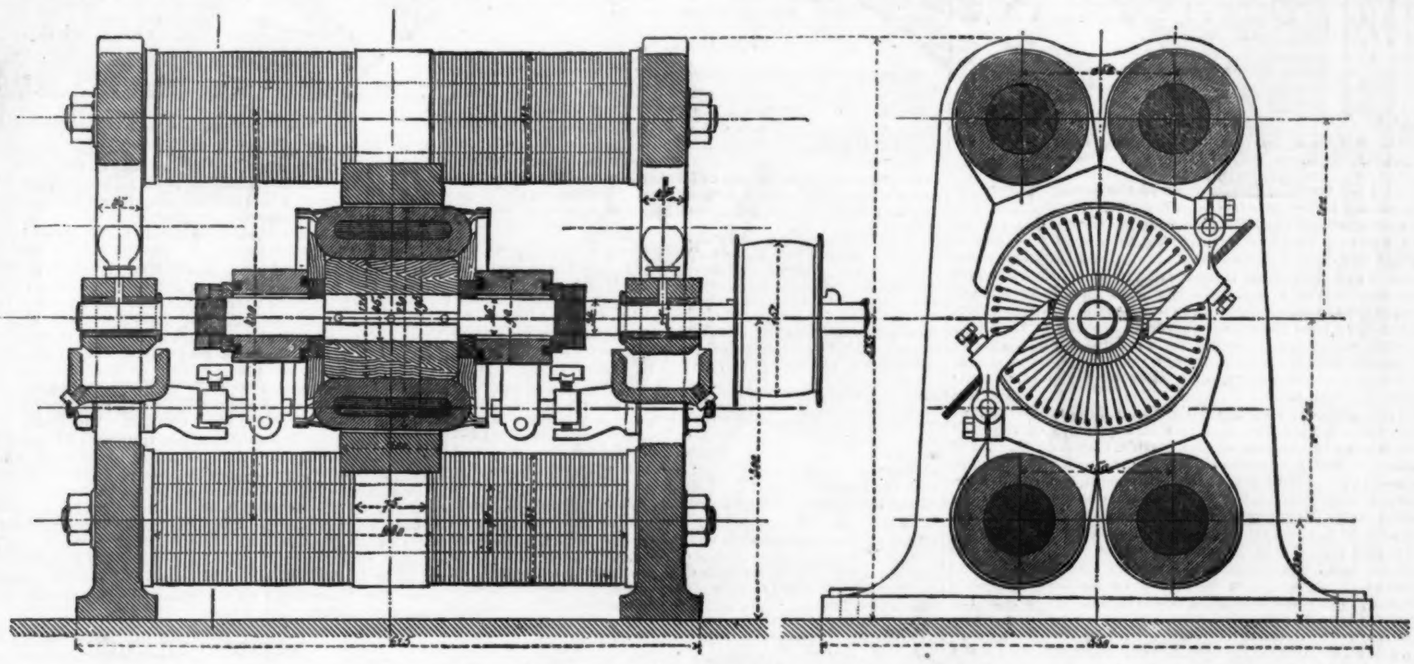
Outside diameter of soft iron ring..........	6.61 in.
Inside " " " " "	4.84 "
Width of soft iron ring..........	3.97 in.
Outside diameter of bobbin..........	4.68 "
Inside " " "	4.05 "
Diameter of wire..........	.007 "
Diameter of conductor cylinder..........	3.5 "
" " wire to lamp..........	.034 "

MACHINE.

Total length, including pulley..........	25.6 in.
" height..........	19.92 "
" width..........	16.14 "

The large machine supplied a lamp made at the works of M. Gramme with carbons of .123 square inches in section; the lamp for the smaller machine was made by M. Serrin, with carbons of similar dimensions.

The following tables summarize the results obtained:



THE GRAMME MAGNETO-ELECTRIC MACHINE.

TABLE I.—EXPERIMENTS WITH LARGE MACHINE MADE OCTOBER 16TH, 1875.

Ratios of distances of electric light and Carcel lamp from photometer.......... 40 : .93
Ratios of intensities.......... 40 : .93=1850

Numbers of Diagram.	Revolutions of Dynamometer per minute.	Mean Ordinates given by the Diagram.	Foot-pounds of Work per Second.
		in.	
1	238	.865	4063
2	251	.744	4124
3	248	.854	4916
4	244	.653	3698
5	241	.614	3296
6	244	.654	3716
Mean..........	244	....	4127=7.5 H.P. per min.

Work done per 100 burners.......... 7.5 : 1850=.405 H.P.
Work per burner per second.......... 2.23 foot-pounds.

TABLE II.—EXPERIMENTS WITH SMALL MACHINE, MADE DECEMBER 4TH, 1875.

Ratios of distances of electric light and Carcel lamp from photometer.......... 20 : 1.15
Ratios of intensities.......... 20 : 1.15=302.4

Numbers of Diagram.	Revolutions of Dynamometer per Minute.	Mean Ordinates of Diagram.	Work done in Foot-pounds per Second.
		in.	
1	234	.279	1452
2	238	.292	1445
3	244	.298	1651
Mean..........	239	....	1516=2.75 H.P.

Work done per 100 burners.......... 2.75 : 302=.91 H.P.
Foot-pounds per burner per second.......... 4.97

The machines worked with regularity for a sufficient time to prove the absence of heating. Moreover, the work done

was very uniform during the experiments, although one of them was considerably prolonged.

As regards the cost of different modes of lighting, the following data are of interest. The consumption of oil for 1850 Carcel burners per hour equals 1850 × 1.48 oz. = 2738 oz., or about 6800 cubic feet of gas. Under these conditions the cost of fuel would be only the hundredth part of cost in oil, and one fiftieth part of the cost of gas-lighting in Paris. The comparison is less favorable for smaller machines, for from the data given it will be seen that for the large machine, each Carcel burner requires 2.23 foot-pounds, and for the small machine to 4.97 foot-pounds, or double the former. This expenditure of work would, according to M. Heilmann, be increased to 8.85 foot-pounds for each burner in a hundred-light machine.

The application of the magneto-electric machine for lighting purposes is increasing. For more than a year the works of MM. Heilmann, Ducommun, and Steinlen, of Mulhouse, are illuminated by four-hundred light lamps inclosed in depolished glass, and every part of the works is perfectly lighted. The workshops of M. Pouyer Quertier are lighted in the same manner, and the Paris station of the Northern Railway of France is about to be illuminated by the electric light. A lamp of 100 burners, to light a workman as well as would an ordinary lamp placed 18 in. away from him, may be situated 16.5 ft. away; a lamp of 300 burners may be 28.5 ft., and one of 1850 burners at 70 ft. 4 in. distant; and these figures show that the largest sizes of lamps may be most usefully employed for lighting manufactories. It should also be observed that the dissemination of the light received by the ceilings and walls constitute, beyond the direct action of the lamp itself, a general distribution, so good that reading is possible even in the most obscured part of the inclosure lighted. This result is more surely attained by means of some less powerful lamps, the shadows cast by some being effaced by the illumination of the others.

The irregularities in the carbon points can no doubt be overcome, when special attention is paid to their production, and they cease to be made from gas coke. For report of a recent experimental lecture on the Gramme machine, at the Stevens Institute, Hoboken, N. J., by Prof. G. F. Barker, see *Scientific American*, March 26th, 1876.

[Nature.]

THE EFFECTS OF THE SUN'S ROTATION AND THE MOON'S REVOLUTION ON THE EARTH'S MAGNETISM.

When the mean horizontal force of the earth's magnetism for each day of the year has been deduced from well-corrected observations of the bifilar magneto-meter, and the results have been projected in the usual way, the curves thus obtained show successions of maxima and minima occurring in some instances at nearly equal intervals and in others abruptly and apparently without law. It has been found that these changes are experienced similarly at all stations where observatories have been placed on the earth's surface; they are, therefore, variations of the magnetic force of the whole earth. The results now considered, though derived from the observations at a single station, may thus be accepted as true generally for all places.

In the projection of the daily mean forces observed at Makerstoun in 1844, the first and last quarters of the year showed large oscillations of the earth's magnetic force, the maxima occurring near the times of new moon and the minima near those of full moon; the ranges of the oscillations were not equally great, and the oscillation disappeared in the months near midsummer. The mean result for the whole year seemed to show that great changes of the earth's magnetic force were due to the moon's position relatively to the earth and sun; but no explanation could be offered for the apparent irregularities in the lunar action. Eleven years later (in 1857), while discussing observations made near the equator, I became persuaded that the variations in question were really due to the sun's rotation on his axis. The result of a re-examination of the Makerstoun observations gave a mean period of nearly twenty-six days for the most probable duration of the magnetic oscillation.

Astronomers who till then had occupied themselves with the determination of the time of the solar rotation, had found for it from 27.3 to 27.7 days. It was difficult, in the face of this result, to suppose that the magnets were better acquainted with the true time of the sun's rotation than the eminent observers, who, with the best telescopes, had watched the movement of the solar spots; and it was suggested that a movement of the sun's magnetic poles might explain the difference of the periods obtained. More recently, however, it has been found that the spots give considerably different times for the sun's rotation, and especially that those nearest the solar equator indicate, as Spoerer has shown, a period of 26.3 days, thus approaching nearly to that obtained previously from the magnetic observations. Dr. Hornstein, director of the Prague Observatory, discovered, independently, nearly the same period from his observations in 1870.

There still remained for explanation the irregularities already noticed in the lengths and ranges of single oscillations. I, on a reconsideration of all the discussions previously made by him, arrived some time ago at the conclusion that the results obtained for the solar and lunar actions did not exclude each other, but that both sun and moon were concerned in the changes of the earth's magnetic intensity; and that possibly the variations in the character of the single oscillations were due to the sun and moon sometimes acting in the same and sometimes in opposite directions; just as in the case of the oceanic tides, for which the differences would be even greater were the solar more nearly equal to the lunar action.

This conclusion is put to the test; the mean variations derived from the observations for each of two successive years are calculated for periods of 26, of 27.3, and of 29.53 days, the two latter being the times of the lunar, tropical, and synodical revolutions respectively. The variations for each of these three periods corresponding to the positions of the moon and of a given solar meridian for each day of the year are then added together; the sums should represent the total actions of the two bodies for each day, and if no other causes are in question, they should agree with the observed variations.

I have shown that when the calculated results are projected so as to form a red curve, on the same mean line as a black curve representing the observations, the two agree very nearly with each other throughout the two years. The different durations and ranges of single oscillations, and the total disappearance of the latter in certain months, are found to be produced, as was supposed, by the greater or lesser agreement or opposition of the three actions.

These results demonstrate, I think, not only that the sun's rotation and the moon's revolutions produce variations of the earth's magnetic force, but that all the marked variations are really due to these causes.

There appears to be one exception to the generality of this conclusion, in sudden great changes, generally diminutions, of the earth's magnetism, which appear of variable magnitude and apparently at irregular intervals. I have examined these cases, and find that if a considerable diminution of intensity happen suddenly when a given solar meridian is in the same plane with the earth, that a similar sudden diminution generally occurs twenty-six days or some multiple of twenty-six days after, when the same solar meridian and the earth are again in the same plane. In one case the sudden loss of force begins five times in succession at the exact interval of twenty-six days.

If we examine these cases of successive disturbance when a given solar meridian arrives opposite the earth, we are induced to conclude either that the solar action exists only for this position, that is to say, that the earth is its cause; or that the action is continuous, but, unlike light and heat, is propagated only in one direction (or plane); or, which seems more probable, that the medium through which these actions are transmitted proceeds from the sun, is not uniformly distributed around it, nor always distributed in the same way. This idea may aid in explaining many facts in terrestrial magnetism for which hitherto no clue has existed.

We arrive then at the conclusions that the variations of the daily mean magnetic force are due to causes external to the earth, depending on the sun's and moon's motions; that all the principal variations of this force can be calculated approximately for each day in twelve months, on the hypothesis that the actions of these bodies are constant throughout the year for the same positions relative to the earth; and that the great magnetic disturbances (accompanied by the aurora borealis) are due to actions proceeding from certain parts of the sun's surface, since so many of them repeat themselves at intervals of twenty-six days, when the same solar point returns opposite the earth. It appears from other investigations that the sun's rotation produces marked effects on our atmosphere.

MORDANTS.

Probably the most important subject in the technology of dyeing—an accurate knowledge of which is at any rate most important to the dyer—is the action of mordants. If we make a decoction of any of the ordinary dye-drugs, and immerse in it a piece of cotton fabric, the latter will be colored but not dyed, for we understand by the latter term a permanent change of color—more or less lasting it may be, but still sufficiently durable to merit the term. The fibres of the piece of cotton hold the solution of the dye-stuff, but they are unable to render the coloring matter insoluble, and affix it to themselves. Consequently, if we dip it into water the color is again dissolved, and is diffused in the water. In other words, the dye, having no affinity for the fibres, is washed out. The object of the dyer, then, is to find a substance which has a mutual affinity for the cloth and the coloring matter, so that by first combining this substance with the goods to be dyed he is enabled to impart to them permanent colors by the affinity which his dyes have for the substance he has incorporated with his goods. These substances are named mordants, from the Latin *mordeo*, because they were supposed by the older dyers to bite into or open a passage in the fibres for the access of the color. With one or two exceptions all the mordants are metallic oxides—those in general use being alumina, and the oxides of tin and iron; and it is not too much to say, that the principal part of all dyeing operations is the proper choice and application of mordants. For between the mordant and the coloring matter a chemical union takes place, a new substance is formed, which differs not only in properties, but in color, from either of the original substances—so much so, indeed, that slight differences in the strength or quality of a mordant often make a decided alteration in the shade of color. It is the action of the mordant that enables the dyer to produce a great variety of shades from a small number of coloring matters; as, for instance, logwood alone, by means of different mordants, is made to yield all the shades from a French white to violet, from lavender to purple, from blue to lilac, and from slate to black. It must not, however, be supposed that the processes of the dyer are simple. On the contrary, there are many things to study—the nature of the goods, the best mordant, and the best method of treating it; for, although a satisfactory result may be obtained by the simplest process, it often follows that a much better one is obtained by another mordant, or even by the same when differently treated. Thus mordants, which in their normal state have no affinity for the fabric, but have a strong affinity for the coloring matter of the dye-stuff, are acted upon by some agent which proudces in them the required affinity for the fabric, and so far the process may be satisfactory. But it may also happen that this agent which has induced the mordant to combine with the goods has destroyed the affinity between the color and the mordant, and so it becomes necessary to neutralize the action of the agent when it has done its part of the work. This and many other of the simple yet important details of the dyer's art serve to show how necessary must be a knowledge of principles to the practical man who would hope to progress in his profession.—*Textile Manufacturer.*

PHOTO-PAPER.

In the *Bulletin Belge de la Photographique* is a formula for preparing plain salted paper. A warm solution of the following is made up:

Chloride of sodium,	35	grammes
Nelson's gelatine,	35	"
Orange-juice,	35	"
Water,	1½	litres

Paper immersed in this solution, and afterwards dried, is sensitized on a silver-bath in the ordinary way; it is very sensitive.

DRY PLATES WITHOUT COLLODION.

A method is also given of preparing dry plates without the use of collodion. A mixture is made of—

Albumen,	125	grammes
Honey,	110	"
Iodide of potassium,	4	"
Bromide of potassium,	1	gramme
Dry chloride of sodium,	3	decigrammes

The mixture is beaten to a snow, and then allowed to stand for twenty to twenty-four hours. A plate coated with the composition, dried on a stove, and then allowed to cool, is sensitized in the ordinary fashion.—*London Photo. News.*

[Anthony's Photographic Bulletin.]

REMOVING VARNISH FROM NEGATIVES AND FERROTYPES.

By E. K. Hough.

Having occasion to remove silver stains from the varnish of a negative, I flowed it with cyanuret of potassium (saturated solution, one ounce; alcohol 95°, two ounces), and was somewhat surprised to see all the varnish dissolving and flowing off. The action was so energetic that at first I feared the negative would be injured; but in less than a minute it was free of varnish, and I washed it under the faucet, dried and revarnished it, no difference from a new one being noticeable.

Mr. Bierstadt stating that potash in alcohol would accomplish the same result, it seemed probable, and, if so, cheaper. I therefore decided to compare them by experiment in formal scientific fashion, and accordingly selected six negatives, two of them two years old, two one year old, and two just made, none of them redeveloped or strengthened with any thing but silver. Having procured a bottle of "Holman's pure white potash" from a druggist, I mixed one part with two of alcohol and flowed one of each pair successively; and in each case, while it readily removed the varnish, it also seemed to rot the film and so loosen the silver that it either partially or entirely flowed off with the varnish, of course ruining the negatives. On the other three I tried the cyanide and alcohol with perfect success, as in less than three minutes all were free of varnish, washed and drying. As a further trial I cut a larger negative in halves, and, reducing the potash with equal bulk of water, mixed it with two parts of alcohol, as before, and tried it on one half, spoiling it also; while cyanide, as before used, left the other uninjured. I also tried the method on ferrotypes, with the same result, the potash spoiling them, while the cyanide of potash left them clear and bright as when new. I do not claim that the cyanogen has any beneficial effect; I only say that the alkali in that form acted well, while pure potash did not. If not conclusive to others, my experiments achieved the result usual with all photographic experimenters, they thoroughly convinced me that "my method is the best ever discovered" for the purpose, and therefore I confidently recommend it for trial and use.

ESTIMATION OF MANGANESE IN CAST-IRON.

By Sergius Kern, St. Petersburg.

The following method is proposed for the estimation of manganese. The process is easily executed, though very accurate results are not obtained; but, however, in laboratories of iron-works this method may be used, especially for the analysis of spiegeleisen.

0.5 grm. of the sample is dissolved in a high glass in 15 c.c. of hydrochloric acid, 11.2 sp. gr. At the end of this operation about 0.2 grm. of potassium chlorate is added in order to convert all the iron into ferric chloride. If silica occurs in the sample it is found in the form of a precipitate which is filtered from the solution. The liquor then contains ferric chloride (Fe_2Cl_6), and manganous chloride ($MnCl_2$). A solution of caustic potash is next added; $Fe_2(HO)_6$ and $Mn(HO)_2$ fall down as precipitates; to the solution is immediately added about 40 to 50 c.c. of a concentrated solution of ammonium chloride (NH_4HCl), and the mixture is boiled for about ten to fifteen minutes. The liquor is then filtered from the brownish-red precipitate of hydrated ferric oxide, and to the colorless solution ammonium sulphide ($NH_4.SH$) is added; a flesh-colored precipitate of manganese sulphide (MnS) is obtained, which is filtered from the solution, quickly washed, placed in a porcelain crucible, and heated with sulphuric acid. Manganous sulphate ($MnSO_4$) is then obtained, which, evaporated to dryness and next ignited, yields red mangano-manganic oxide (Mn_3O_4). This oxide is weighed, and as it contains 72·05 per cent of manganese, the percentage of manganese in the sample may be easily calculated.

METALLIC TITANIUM.

By Sergius Kern, St. Petersburg.

In many manuals of chemistry it is proposed to prepare this metal by the ignition of metallic potassium or sodium with the double fluoride of titanium and potassium (TiK_2Fl_6). The titanium obtained by this process in the form of a grey powder decomposes water very easily at 100°; but the experiments prove that the titanium obtained by this method always contains an excess of unoxidized potassium or sodium, and the presence of these metals explains well why the titanium decomposes water at such a low temperature.

By the following method analogous to the production of metallic silicon, titanium is very easily prepared:

Through a tube with a bulb in the middle of it in which sodium is melted, vapors of titanium tetrachloride are passed. Then by the following reaction, titanium is obtained:

$$TiCl_4 + 4Na = Ti + 4NaCl.$$

The mixture of titanium and sodium chloride is washed by means of cold water; the remaining precipitate of titanium is washed with ethyl-ether, and dried over sulphuric acid. Titanium carefully prepared by this process has no action on water at 100° and only decomposes it at about 500°.—*Chemical News.*

IMPROVEMENT IN WATERING.

By M. Tavernier, France.

In order to avoid the *chiné* or *jaspé* appearance arising from the crushing of the threads, the inventor takes advantage of a well-known method called in France *riflage*—that is to say, tension of the fabric, with or without heat. The stuff to be watered is previously submitted to this operation. It is effected by means of an apparatus which is furnished with two cylinders, one for unrolling, the other for receiving, the tissue, and between the two is a hollow metallic cylinder, heated either by gas or by means of red-hot iron bars placed inside, at a given pace.

PURPLE TINT FOR MARKING LINEN.

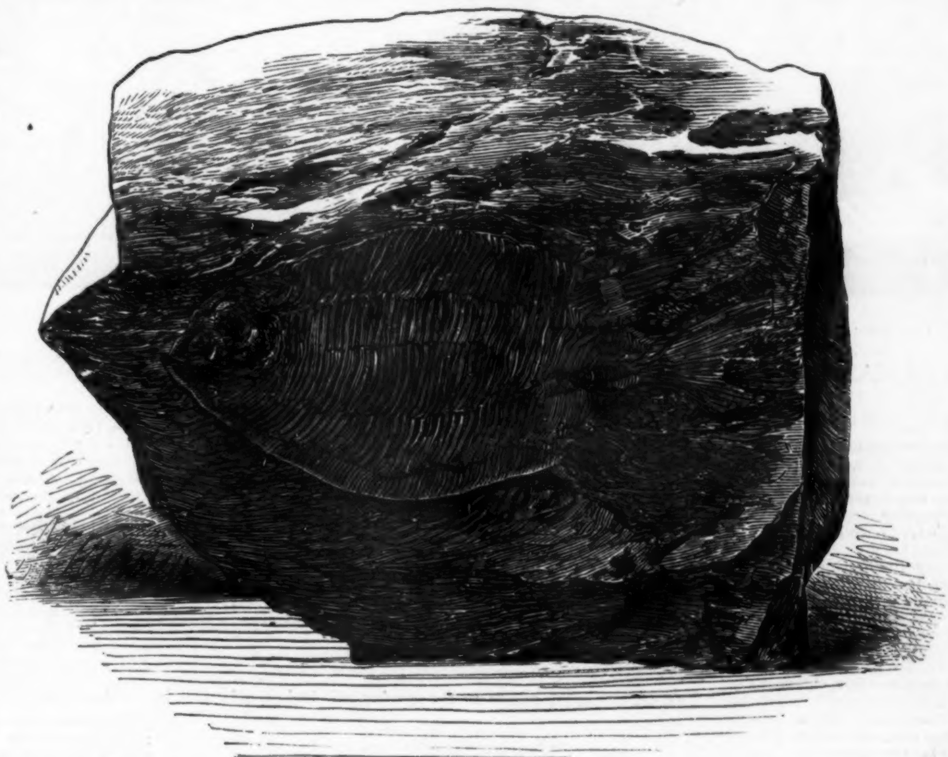
A suitable preparation for this purpose is as follows: Let 5 grammes (1.7 oz.) of sesquicarbonate of ammonium be neutralized in a porcelain mortar with nitric acid, and the perfectly neutral solution have 3 or 4 grammes (.1 or .14 oz.) of carmine ground into it. As a mordant for the linen, use a mixture of equal parts of acetate of argillaceous earth and nitrate of tin. Linen or cotton thus treated and marked with the above preparation will, when perfectly dried, show a purple tint.—*Industrie-Blätter.*

[Town and Country Journal, Sidney.]

THE AUSTRALIAN GEOLOGICAL COLLECTION FOR THE CENTENNIAL EXHIBITION.

THE geological collection is arranged in four glass cases, and is very complete. It will doubtless be highly appreciated by men of science, who will thus have an opportunity of seeing for the first time the most complete *suite* of fossils, illustrative of the geology of New South Wales as yet placed before the public. Here we have all the principal formations represented by their most characteristic fossils from the recent period to Upper Silurian. Commencing with the former, there are shown stone tomahawks, one of which is labeled as having been found by Mr. T. S. Mort, at Bodalla, at a depth of 14 feet below the surface, thus indicating the antiquity of the aboriginal race in Australia; with these are bones of existing animals found in the cave deposits of Mr. Lambie. Next in order, receding from the present period, is the Pleistocene formation, containing the remains of some of those extinct gigantic mammals which inhabited this continent; among them is the Thylacoleo carnifex, or pouched lion; the lower jaw of that huge Diprotodon, the Tasmanian tiger, with bones of wombat and of other smaller animals. The Upper Pliocene formation is next represented by fossil leaves and fruit taken from the auriferous drifts of the deep leads near Orange, Parkes, and Guigong. These fossil fruits include the Penteune Clarkeii, Rhytidocaryron Wilkinsonii, Spondylostrobus Smythii, all named by Baron Von Muller, Government Botanist of Victoria. These fossils, with others, are fully described in the papers by the Government Geologist, and the Rev. W. B. Clarke, M. A., F.G.S., in the "Mines and Mineral Statistics," lately published by the Minister for Mines, in which are given interesting accounts of the gold-bearing deep leads in which these fossils are found near Parkes and Bathurst. The Miocene fossil leaves are from the old tin-bearing deep leads, which are now extensively worked in New-England, and which, in the pamphlet referred to, are described by the Government geologist, and by Mr. G. Gower, mining registrar at Vegetable Creek. Next in order of formation are the Wianamatta beds and the underlying Hawkesbury series. In the former is a photograph of a splendid specimen of a fossil fish—Paleoniscus—collected by the Surveyor-General at the Gib Tunnel on the Southern railway. From the Hawkesbury beds is a very perfect specimen of fossil fish—Cleithrolepis—found by Mr. Thomas Brown, M.L.A., in a railway cutting on the Blue Mountains at a height of 3000 feet above the sea level. The accompanying engraving is from a photograph of this fossil fish, which belongs to that ancient type of fishes with heterocereal or unequally lobed tail like that of the living shark and sturgeon. The Hawkesbury rocks attain a thickness of 800 feet; they form the cliffs around Sidney harbor, and Govett's Leap is a waterfall of 520 feet over these rocks, which form such wild and picturesque precipices in the scenery of the Blue Mountains. Below the Hawkesbury rocks we come to the upper coal measures which contain the workable coal seams of the Newcastle, Bowenfels, and Illawarra coal fields. The fossils illustrating these beds are very interesting. These are very perfect specimens of the Glossopteris Browniana, Phylotheca, Sphenopteris, besides several undescribed fossil plants, supposed to be new species. In the next case are the fossils from the lower coal measures, in which occur the Greta and Anvil Creek coal seams. These fossils, which consist of marine shells—Spirifera, Producta, Conularia, Fenestella, corals, etc.—are found both above and below beds containing the above-mentioned plants. We have thus demonstrated to us the proofs what our venerable geologist, the Rev. W. B. Clarke, has always maintained, that the fossil plants of the upper coal measures are associated in the lower, with marine fauna, of carboniferous age. Next are the Knorria, Lepidodendron, and other lower carboniferous plants, with marine shells, Enomphalus, Spirifera, Strophomena, etc., from near Port Stephens, collected by Mr. John M'Kenzie, Examiner of Coalfields. The Devonian beds are represented by sandstone full of Spirifera, Rhynehouella, etc., with Lepidodendron from the Mount Lambie beds, in the Rydal district, and there are also some of the same Devonian Brachiopoda and Lepidodendron, found by Mr. John Hume, near Goulburn. Completing the series of formations, we have, lowest the Silurian, with its corals—favorites, Halysites catenipora, Orthoceras, Cyathophyllum.

Altogether, this collection of fossils, which has been classified and arranged by Mr. C. S. Wilkinson, Government Geologist, and his assistants, forms about the most complete one of kind yet exhibited, and will give to the public an admirable illustration of the geology of New South Wales. Considering the recent establishment of the Department of Mines, great praise is due to its officers—Mr. Harrie Wood (Under Secretary), the Wardens, and others, for having brought together so good a geological and mineralogical collection.



THE INTERNATIONAL EXHIBITION OF 1876.—AUSTRALIAN GEOLOGICAL EXHIBIT.

CLEITHROLEPIS GRANULATUS (NATURAL SIZE).

Fossil fish found in "Hawkesbury Sandstone" formation, in railway cutting, near Blackheth, Blue Mountains, New South Wales.

[Nashville American.]

A PYGMY GRAVEYARD IN TENNESSEE.

AN ancient graveyard of vast proportions has been found in Coffee County. It is similar to those found in White County and other places in Middle Tennessee, but is vastly more extensive, and shows that the race of pygmies who once inhabited this country were very numerous. The same peculiarities of position observed in the White County graves are found in these. The writer of a letter describing the burying-place says: "Some considerable excitement and curiosity took place a few days since near Hillsboro, Coffee County, on James Brown's farm. A man was ploughing in a field which has been cultivated many years, and ploughed up a man's skull and other bones. After making further examination, they found that there were about six acres in the graveyard. They were buried in a sitting or standing position. The bones show that they were a dwarf tribe of people, about three feet high. It is estimated that there were about 75,000 to 100,000 buried there."

DISCOVERIES IN EGYPT.

A CORRESPONDENT of the *Academy*, writing at Luxor on February 2d, says: "A remarkable discovery was made a few days since at a spot to the north of the obelisk, in the great temple of Karnac. Some Arabs, digging among the ruins for the dust with which at this season of the year they manure their land, came upon a kind of cist, made of sandstone, which they unfortunately broke. Inside this cist was found a superb figure of a female hippopotamus, carved in green basalt, standing upright in the usual conventional manner, and carrying on either side an emblem or symbol. The finders concealed the treasure, and having removed it to the house of one of their number, covered it with the straw of dhourra corn. The affair, how ever, through jealousy, was soon revealed to the authorities, and the Governor of Luxor went by night with soldiers to the house where the treasure was concealed. The unhappy owner denied all knowledge of the affair, but having received, *more Turco*, fifty strokes with the bastinado, he confessed that 'a friend' had hidden it, and at length pointed out its hiding-place. The figure was then removed, placed in the British Consulate, and next morning handed over to Marietta Bey, who chanced to be at Luxor in his steamer. The monument, including the slab on which it stands, is about three feet high, and is carved with admirable precision, and highly polished throughout. A long inscription in hieroglyphics runs down the back, and another is inscribed at the base in front of the figure. The hindermost inscription is the best executed, but both are far inferior in execution when compared with the statue itself, which is in the finest style of art, and even superior to the celebrated green basalt cow of the same epoch in the Museum of Boulak. The inscriptions contain the names of Psammetichus I. and his queen and daughter, and on the ovals on the sandstone cist already mentioned there is in addition the name of a king hitherto unknown."

LIMITS OF PERCEPTION IN REGARD TO MUSICAL TONES.

THIS subject is dealt with by Prof. Preyer, of Jena, in the first of a series of original papers on physiological subjects which are to be published under his editorial supervision (*Physiologische Abhandlungen* herausge geben von W. Preyer. Jena: 1876). He has endeavored to fix the lowest and highest limits of pitch within which musical tones can be perceived, by means of experimental methods of greater precision than any that have been hitherto employed for the purpose. The minimum limit of the normal ear was found to lie between sixteen and twenty-four single vibrations per second; the maximum limit reached 41,000; but many persons with average powers of hearing were found to be absolutely deaf to tones of 16,000, 12,000, and even fewer vibrations. The author then proceeds to inquire into the power of discriminating relative pitch and of appreciating musical intervals. In the last section of the paper he treats of silence, defining it as a state of uniform minimum excitation of the auditory nerve-fibres, and joining issue with Fechner and others who deny its claim to be regarded as a positive form of sensation at all. Fechner distinguishes between the effect of absence of light upon the eye, and that of absence of sound upon the ear; black he regards as a sensation, silence as an absence of all sensation. Preyer points out, on the contrary, that the two cases are in every way analogous, and that the auditory organ never sinks, any more than the retina, below the zero of sensation. The pressure of the fluid contents of the labyrinth, and the flow of blood through the vessels, must give rise to sensations of which we are unconscious only because of their uniformity, their constancy, and their low degree of intensity. Silence, when the attention is concentrated on the sense of hearing, is found to vary in degree, just as the blackness of the visual field, when light is excluded from the eye, has been observed to vary. But the complete absence of sensation is obviously incapable of varying. Lastly, the parallel between the auditory sense and that of vision is borne out by a study of the entotic sensations which may be produced artificially, and which are closely analogous to well-known entoptical phenomena.

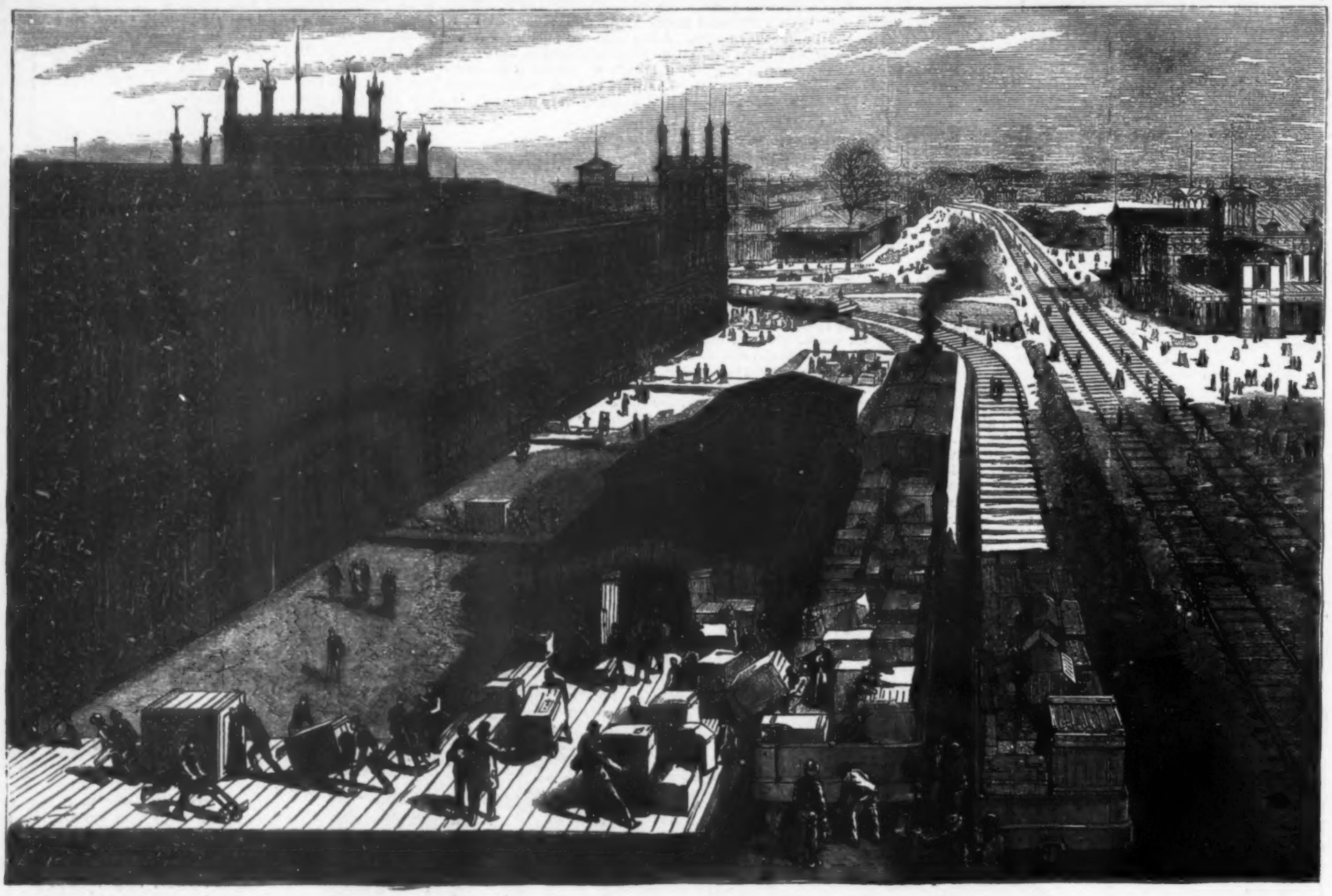
THE MAMERTINE PRISON, ROME.

THE seven chambers of the celebrated great ancient prison of Rome of the time of the kings and of the republic (which are now cellars under the houses between the Via di Marforio and the Vicolo del Ghettarello) are now in the hands of the British and American Archæological Society. The entrance is through the ancient vestibule or the guard chamber of the prison, commonly called the Prison of St. Peter, or the Mamertine Prison, from a statue of Mamertus or Mars, which formerly stood on the wall on the opposite side of the street where an inscription recording this still remains. From the vestibule there is a subterranean passage of Etruscan character a hundred yards long, and from this an entrance to the first of the seven chambers of the great prison in which Jugurtha and his companions were incarcerated. The visitors then go through the whole seven chambers and go out in the Vicolo del Ghettarello. At the further end there is a manhole in the vault of each of the chambers for letting a prisoner down with cords.—*The Tourist's Directory.*

SOUTH PARK, COLORADO.

By C. S. RICHARDSON.

AN examination of the map of North-America will reveal among the Rocky Mountains a series of internal level lands or plains, called "parks." They will be seen to continue consecutively in a north-westerly direction. They are divided, as well as surrounded, by lofty ranges of mountains. They are accessible one to the other by and through certain low gaps, called "passes." At an early period, somewhere about the close of the Trias and the Jurassic era, they formed extensive brackish-water lakes, the shores of which in many places are very distinct, being represented in the wave-lines and ripple-marks left in the muddy sediment, now consolidated into solid sandstone and shales. Those best known are the South, Middle, and North Parks. The South Park has recently come into prominence from the mineral deposits found in its encircling mountains. These are lofty ranges, having peaks exceeding 14,000 feet above the sea-level, among which are Gray's Peak, Mount Lincoln, Mr. Bross's Horseshoe, Buffalo, Buckskin, and others of less note. Their chief mineral product is silver, lead, and copper. Bismuth has been found sparingly, and a little antimony. The large streams and many of the gulches that cross or cut through the mineralized formations are rich in alluvial gold, and are now the sites of extensive "placer-works," most of which are doing an exceedingly good business, and their respective owners making handsome returns on their investments. The town of Fairplay is the county-seat; it is pleasantly located on the left bank of the river Platte, and is already a place of considerable business. About three years ago it was nearly all destroyed by fire; but, like all mining towns, is being rapidly rebuilt. It has a population of about 500 inhabitants; it has two excellent hotels, two churches, schools, a new stone-built court-house, many stores, one printing-office (where the *Sentinel* newspaper is published), and a variety of saloons and places of amusement. Close to the town are very large "placer-works"—and, so far as practical planning goes, are the most complete of any in Colorado. There is one main flume, over three quarters of a mile in length, using the hydraulic-pressure system; this is in the Platte River. The diluvial is from 70 to 120 ft. deep. The detritus from the washings are exceedingly interesting to the geologist. They give a thorough exposition to the mineralogy of the mountains. A railway, named the Denver, South Park, and Utah, has been commenced. The metals have been laid for twelve miles, and in operation as far as the town of Morrison. It will pass through the town of Fairplay, and thus bring this point within five hours' ride of the capital of the State—Denver. The altitude of the Park is about 9640 ft. above sea-level; the climate exceedingly variable; temperature low. During my stay in the months of July and August the thermometer ranged at an average of 52° Fahr.; at the same time it was in Denver from 90° to 110°. This South Park is about seventy miles long and forty miles wide, slightly undulating, with a south east inclination of about 25 ft. to the mile. Its great altitude, variability of temperature, brief duration of the maturing season, and excess of alkaline substances in the soil, with the late frosts of spring and early ones in autumn, render it uncongenial for agriculture; but for pasturage it is excellent, which may be attested by the numerous herds of cattle and flocks of sheep, all in the finest condition, that browse at will on its luxuriant herbage. There being a perfect natural drainage for the salt marshes and alkali flats, with no bogs or swamps, the sanitary condition of the country is as perfect as well can be; consequently a general state of good health prevails among the people.



Main Building at left.—Machinery Hall beyond Main Building. 2. Custom House. 6. Spanish Building. New-York State Building at right.

THE INTERNATIONAL EXHIBITION OF 1876.—ARRIVAL OF FOREIGN EXHIBITS.

PRESENT ASPECT OF THE EXHIBITION.

As the date for the opening of the Centennial International Exposition at Philadelphia rapidly approaches, the population of that usually staid city becomes more and more excited. So says *Frank Leslie's Newspaper*, from which we derive the following particulars and also our engravings.

Arrived on the grounds the visitor is at once launched into a scene of great activity and bustle. On all sides buildings are in course of erection, or receiving the finishing touches. Huge hotels, of cheap construction but gaudy appearance, stores and dwelling-houses, restaurants and beer-saloons, all bright with new paint, and all gaily decked with flags, abound.

THE MAIN BUILDING.

The first structure to attract attention after entering the grounds is the Main Building. In this mammoth, yet artistically constructed edifice, the visitor finds that a space some forty feet square has been railed off inside the doorway, beyond which no one is allowed to pass without the necessary credentials, which are now limited to those having actual business on the floor. A good view, however, can be had of the busy scene from this point, and every one is struck with the extensive arrangements that are going on in the way of fitting up the space by the exhibitors and foreign governments. At many points carpenters, painters, and others are busily engaged setting up novel and ornamental pavilions for the display of the valuable exhibits that are already here or are about to arrive. Boxes and bales, many of them of very large proportions, are piled upon the spaces set apart for them, and numerous packages have been opened and the goods placed in position. The foreign nations are foremost in this matter, the operations in the American section being very backward. The British section has all been carefully laid out, and the name of each exhibitor is distinctly painted on the space allotted.

Near the west entrance a tasty inclosure is being erected for the Chilian Government. At one end is a pavilion, which is a beautiful piece of ornamental wood-work, and will, when painted and decorated, be very attractive. Across the way, Norway is putting up an inclosure of Norway pine, and close by Sweden is at work on a pavilion of a very artistic character. The material in these buildings, and the workmen engaged in their construction, were brought here by the Commissioners from Norway and Sweden.

THE SPANISH DEPARTMENT.

Spain has 11,253 square feet in the Main Building, facing on the nave, between Egypt and Russia. She incloses her passageways, right and left, and makes the entrance through grand portals in the centre. This inclosure at the main front will be 46 feet in height, the material being wood and canvas, which will be painted, carved, and gilded in a very rich and elaborate style. There will be a grand doorway in the centre, and two side portals, all handsomely decorated. The central entrance is surmounted by a massive pediment, broken in the centre, the middle part being graced with a painting representing Spain in the act of disclosing the Western Hemisphere to the assembled nations. Below are portraits of Columbus, Isabella, wife of Ferdinand, Cortez, Pizarro, De Soto, and other heroes of Spanish discovery. The doorways are to be hung with heavy folds of silk curtains—red and yellow, the Spanish national colors. The pediment is to be surmounted by a grand trophy of shields, helmets, and standards won from the Moslem.

EXHIBITION NOTES.

THE opening exercises promise to be short and simple. They will be held in the open air, and will occupy not more than one hour. There will be an ode by Mr. Bayard Taylor, a cantata by Mr. Sidney Lanier, some other music, instrumental and vocal, a brief address of welcome to President Grant, and an equally brief response. Then will follow a formal tour of inspection by the President and suite, the marching to be set in motion when the party reaches the centre of Machinery Hall. Simplicity and dignity, it is to be hoped, will be the distinguishing characteristics of the affair.

THE INTERNATIONAL EXHIBITION OF 1876.—THE SPANISH BUILDING

THE list of invited guests to the opening will include all the Governors and their staffs, all the Congressmen, all the presidents of the great colleges, all the leading lawyers, such as Evarts, O'Conor, and Jeremiah S. Black; all the famous engineers, such as James B. Eads, of St. Louis, and Ericsson, of New-York; all the great journalists, the leading architects, painters, and sculptors—in a word, all the men who stand at the head of their professions. The President and his staff and two hundred judges will be there *ex officio*.

THE latest idea of the women who are working for the Centennial in New-York is the "Borrowing Fund," for the benefit of artists who need assistance in exhibiting their works or inventions. The first to enjoy the benefit is Miss Manners, printer of illuminated monograms, who will thus be enabled to take her pr[illegible] to Philadelphia.

THE prizes for the International Regatta, to be held in June, are of original design, and will be costly and beautiful. The pair-oar prize will be a silver vase with a cover; the graduates', a silver vase; the College, a vase with a cover; the prize for the winner of the single-shell race, a badge with a monogram of the Schuylkill Navy, set in diamonds; the double-scull prize, two oarsmen bearing upon their shoulders a boat and oars; the international prize, a tureen, on the face of which a view of the Schuylkill River will be engraved, and to be surmounted by a representation of the dome of the National Capital, capped with the Goddess of Liberty.

THE programme of the Centennial Eisteddfod promises a most attractive series of exercises. The prizes offered embrace one of $125, for an essay on the Constitution of the United States, and another of $75, for one on Eminent Welshmen of America. For poetry, five separate prizes are offered, ranging from $85 for an Ode on Liberty, to $10 for six stanzas on the Centennial Celebration. The prizes to be sung for are numerous and attractive, the largest being $1000 for the best rendering of Beethoven's Hallelujah to the Father, by a choir not less than 150 in number. Rev. R. R. Williams, Minersville, Pa., is the corresponding secretary of the association.

THE *Nation's* correspondent remarks that, "It may not be safe or fair to give an opinion of the Centennial in its ensemble at this early day. The next two months will probably develop a great many novel features of beauty and merit, and give the exhibition an air of finish which it does not yet possess. Nevertheless, he ventures to say this much in advance of the season: The Centennial will not afford any one view so imposing as that of the Rotunda at Vienna from the southern entrance. It will not have any one building so unique as the Khedive's Palace—any one private exhibition so complete and artistically arranged as those of Prince Schwarzenberg and the Duke of Coburg. Neither will there be any one part of the grounds so perfectly attractive as the Mozart Circle and the upper end of Elizabeth avenue. Yet the Centennial grounds, *as a whole*, will probably prove much more picturesque and less wearisome to the eye and foot, and the buildings will be more convenient of access, and will display their contents to better advantage.

IN one thing at least the Centennial Exhibition will stand unique. With all its vastness, and in spite of financial embarrassments, the buildings are ready for the reception of exhibits in ample time for complete preparation before the opening day. The only source of danger now is the tardiness of exhibitors in sending forward their goods. It will be their fault, not the managers, if any portion of the display is incomplete at the critical moment.

To the Smithsonian Institution has been allotted the systematic exhibition of all the precious mineral resources of the United States, and it will be very rich indeed; also, the natural history of the United States, birds, beasts, fishes, and other animals, wild and domesticated, including the processes, work, and progress of the United States and State Fish Commissions for the protection and propagation of food fishes; and also the exhibition of the historical, ethnological, and archæological illustrations of the Indian aborigines of this continent, including their weapons, utensils, dresses, pottery, rude works of art, ornaments, lodges, furs, skins, peltries, burial remains, effigies, etc., etc. To these it is now proposed to add the bringing of living delegations and families here from all the wild Indian tribes and bands, from the far-off Esquimaux of Alaska, to the warlike Sioux, Comanches, and Apaches, and all the intermediate types. These, if the plan shall be approved by Congress, are to bring with them everything portable that will illustrate their habits, manners, employments,

THE INTERNATIONAL EXHIBITION OF 1876.—THE OHIO STATE BUILDING.

sports, and ways of life at home in the wilderness and on the prairie, and, of course, their ordinary costumes, weapons, utensils, and specimens of their peculiar manufactures.

THE Ohio Centennial Commission has authorized the State Archæological Association to take charge of the Department of Ohio Antiquities for the Exhibition. The exhibits will comprise all articles fabricated by the Mound Builders, or Indians, whether in stone, flint, bone, shell or copper, such as hammers, mauls, axes, wedges, tubes, perforated balls, rollers, beads, ornaments, arrow-points, spear-heads, pestles, and every ancient thing that is clearly artificial. The proper arrangement and care of this Department has been entrusted to Professor M. C. Read, of Hudson, Ohio, who will also make a full report and description of all articles exhibited, which report will be published with the proceedings of the annual meeting of the association.

THE colossal bronze statue of Humboldt, to be erected in Fairmount Park, has already been cast in Berlin. The figure is nine feet high, and stands beside a globe upon which the left hand rests. A loose overcoat with wide sleeves comes down below the knee, and conceals in great part the modern costume that is the despair of sculptors. The right hand holds the coat back from the breast and shoulder, and also grasps a roll of manuscript in which appears the word "Cosmos." The head is slightly bent forward, and the face represents the great student of nature as he appeared between his sixtieth and seventieth year.

GERMANY will also be represented by a colossal statue of Bismarck in bronzed zinc. The figure, ten feet in height, represents the Imperial Chancellor in the uniform of a Landwehr cavalry officer.

THE following notice has been issued by Dr. William Pepper, Director of the Medical Bureau of the Exhibition: "In order to provide for any cases of accident or sudden sickness which may occur among the large number of persons who will visit the Exposition, a suitable building is now being erected, to be known as the Office of the Medical Bureau, where every facility will be provided for the immediate gratuitous relief of any such cases. The following staff of officers has been organized, at least one of whom will be on duty at all times when the Exposition is open: Drs. Jacob Roberts, S. W. Gross, H. C. Wood, Roland G. Curtin, Hamilton Osgood, and Theodore Herbert."

SOME one with a head for figures has demonstrated that the goods that will come to the fair would fill a train of freight cars 45 miles long. If this immense mass of all sorts of articles is to be dumped in Fairmount Park a week or ten days before the exhibition opens, it will not be in the power of human skill and energy to unpack them and get them in place in time. All exhibitors who can send their things during the present month should not fail to do so.

THE Grand Division of the Sons of Temperance of Pennsylvania will provide the means of supplying ice-water free to all visitors on the Centennial grounds. A fountain will be erected at the intersection of Belmont and Fountain avenues, about midway between Horticultural Hall and the Catholic Fountain, and it is contemplated to have it in working order by the 1st of May.

Two iron observatories, each 225 feet high, are in process of construction on Lemon and George's hills.

THE original draft of the Declaration of Independence will be placed in the Government building at Fairmount Park, during the Centennial. An iron safe has been prepared for its reception.

A BUILDING for the Centennial Medical Department, at which sick or injured persons will receive gratuitous medical treatment, has been commenced on Agricultural avenue, south of the Brazilian Pavilion. It will be 70 by 70 feet, and will contain a dispensary, medical and surgical rooms, etc.

UPWARD of one hundred foremen from the workshops of France will attend the Exhibition to study American industrial progress.

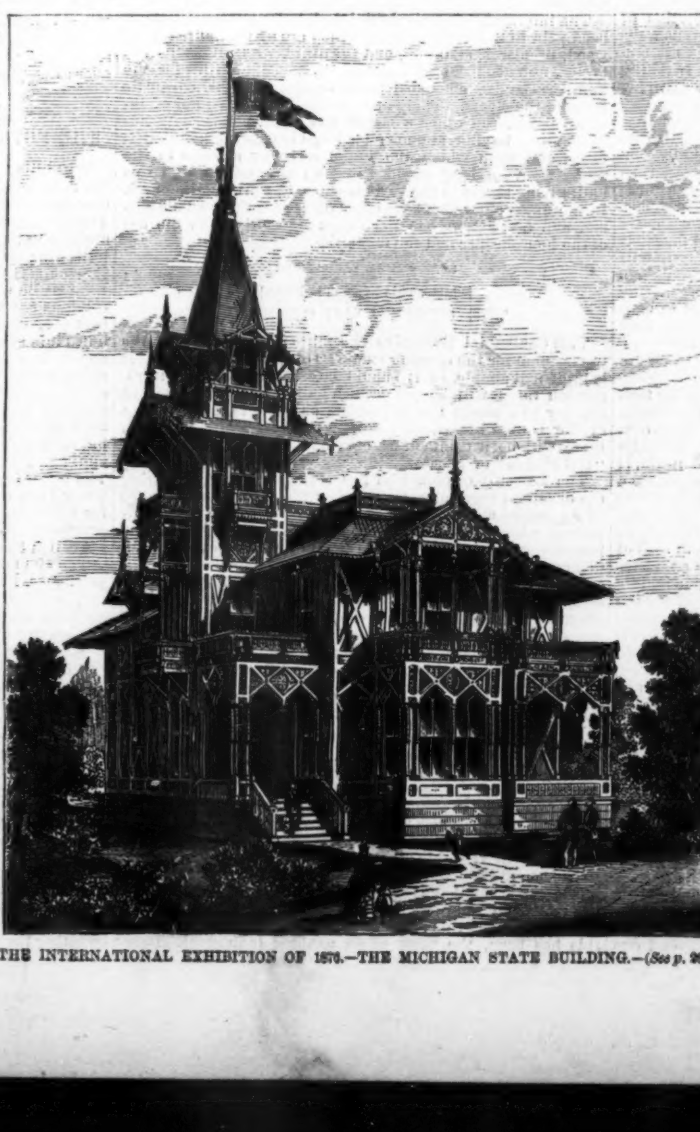
SEVERAL newspapers are erecting buildings on the grounds for the accommodation of their correspondents. That of the Boston *Herald and Advertiser* will stand on Fountain avenue, opposite the northwest end of Machinery Hall. The New-York *Tribune's* will be situated on the north shore of the lake, near Belmont avenue. The *Evening Herald* of Philadelphia will publish a daily edition on the grounds, the paper being edited as well as printed on the spot, in a commodious special building now in process of erection. The afternoon edition of the Philadelphia *Times* will be printed in Machinery Hall.

THE Brazilian Government has appointed the following gentlemen to act as its Commissioners to the Centennial Exhibition: Councillor A. P. de Carvalho Borges, Minister at Washington, President; Councillor F. Lopez Neto, Vice-President; Major J. M. Da Silva Coutinho, Secretary; Drs. Nicolau J. Moreira, J. Saldanha da Gama, P. G. Paes Leme, and H. Rodrigues de Alvarenga, members.

THE Queensland exhibits already arrived are chiefly individual contributions, the Government sending little except colonial maps. The most impressive articles are two pyramids of metal—one of tin, twelve feet high, the other of copper. Though discovered only two years ago, the tin mines of Queensland are already so productive that—according to Commissioner Mackey—the metal can be sent to this country for one third the present price.

THE London Artizan's Institute for Promoting General and Technical Knowledge have taken steps to secure the sending of a deputation of English workmen to the Exhibition.

IT is scarcely to the credit of American exhibitors that they shou'd be the last on the ground. Egypt, Japan, Sweden, and Norway had their exhibits ready before the first American article was put in place. Holland is now on hand with all her goods. Germany, France, Spain, and the far-away colonies of Australia and South Africa have many, if not all, of their exhibits here; and yet there is no little anxiety felt on the part of the Centennial Commission, because of the dilatory action of American exhibitors. It would be humiliating in the extreme if their fears were even partially realized, seeing that the buildings have been in readiness for weeks, in some cases for months.



THE INTERNATIONAL EXHIBITION OF 1876.—THE MICHIGAN STATE BUILDING.—(See p. 262.)

Scientific American Supplement.

No. 17

FOR THE WEEK ENDING APRIL 22, 1876.

PUBLISHED WEEKLY,
AT THE
OFFICE OF THE SCIENTIFIC AMERICAN,
No. 37 Park Row, New-York.
MUNN & CO., Editors and Proprietors.
O. D. MUNN. A. E. BEACH.

The Scientific American Supplement is uniform in size with the *Scientific American*. Terms of subscription for Supplement, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

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THE INTERNATIONAL EXHIBITION OF 1876.

THE MICHIGAN BUILDING AT THE CENTENNIAL.

(See illustration on page 261.)

The building stands about 1000 feet north of and facing the main exhibition building, with the agricultural building about an equal distance to the northeast, while the United States Government building and the building erected by Great Britain are a short distance to the southeast. The narrow-gauge passenger railway which runs around the entire Centennial grounds passes in front of the Michigan building. The site is elevated and commands a fine view of the surrounding grounds. The building is of the Swiss style of architecture. Its outline is very graceful, and the exterior is elaborate and ornamental. The ground plan shows an area of about 50 x 65 feet in size. The foundation is of stone with exterior facing above ground of Lake Superior sandstone.

This building is a representative one, being constructed entirely from Michigan material and of Michigan workmanship. It is designed to show to a certain extent the resources of the State in respect to building material. The brown stone foundation is from Marquette quarries; the slate of the roof is from Huron Bay, Lake Superior. The entire interior finish is of native woods, marbles, or alabster, highly polished. The floors are laid with hard wood of various kinds and colors, and in fancy patterns. The doors are of solid walnut, elaborately carved; the main staircase is a marvel of beauty and skill. The wainscoting in all the rooms is paneled in beautiful designs of various woods or other material. That in the reception room is of highly-polished alabaster from the quarries at Grand Rapids; that in the Governor's office, as well as the mantel in the same room, is of marble.

The furniture will be of the very finest character, made of Michigan material and of Michigan workmanship, contributed by manufacturers in different parts of the State. The walls will be ornamented with pictures by Michigan artists. The large painting by Robert Hopkin, entitled "Off Sleeping Bear Point, Lake Michigan," will occupy a prominent position in one of the rooms.—*Detroit Post.*

EXPERIMENTS ON FLEXURE OF BEAMS.

The curvature, change of inclination, and deflection of beams under different loads and supported in different ways is determined by the aid of the integral calculus, as all students of the resistance of materials are well aware. In taking the first step we avail ourselves of an approximation, a supposition that a distance along the curve of the beam is sensibly equal to the horizontal projection of that distance, or that $ds = dx$. The slight deflections admissible in practice do not make the error large enough to be appreciable. The deflection of a simple beam or truss does not concern us much further than that it indicates the comparative stiffness of the piece, and we can see that a slight change of deflection would not be of material moment. But when we come to investigate the subject of continuous girders, and find that the equations for change of inclination and for deflection of each span must be used, in order to obtain the bending moments, supporting forces at the several piers, and the shearing forces, by the aid of all which quantities the proper proportions of the various pieces are ascertained, a suspicion may be sometimes aroused whether the approximation above referred to may not allow errors to accumulate so as to vitiate the results.

A very simple piece of apparatus may be devised for testing with a light wooden bar the results obtained by calculations from the formulæ. We will describe one used by ourselves which can be duplicated by anybody, and which, while giving satisfactory results, may be made more delicate, if desired. Near the ends of a board, about 30 inches by 4 inches are fastened two standards of wood, the width of the board, some six inches high, and distant 25 inches from centre to centre. These standards each carry a stout iron wire thrust horizontally through them near their tops, and are cut away sufficiently to allow a light bar of wood, about 40 inches long, $2\frac{1}{2}$ inches wide, and $\frac{1}{4}$ inch thick, to rest on the middle portion of the wires which thus make the bearings for the beam of 25 inches span. There are needed also, one or two small pieces of looking-glass, some weights, a graduated rule or scale, a leveling rod and a transit, although one or both of the last two may be, if necessary, dispensed with.

The simplest case is that of a beam fixed at one end and loaded at the other. If l represent the length of the beam, in inches; I the moment of inertia which for a beam of rectangular section is $\frac{b h^3}{12}$, where b = the breadth and h = the depth of the cross section of the beam, all in inches; E the modulus of elasticity; and W the weight in pounds at the end, the formula for the deflection of the loaded end is written

$$v = \frac{W l^3}{3 E I}$$

The value of E may be taken from the tables usually given in text-books, but we prefer to determine it from the experiment on this case. Set the apparatus on the floor, allowing the bar to project a convenient known distance beyond one support, while resting on both. Place the small mirror on the bar, over the support next to the overhanging end. Set up the transit beyond one end of the apparatus and the rod beyond the other end so as to view the reflected image of the leveling rod in the mirror; sight at a point in the mirror as near as possible over the support, clamp the telescope and note the division of the rod cut by the cross hair; measure the height of the extremity of the bar from the floor. Now hang a known weight on the free end of the bar. The end will be deflected and the mirror will move through a small angle, displacing the image of the rod. As a beam fixed at the end is to be horizontal there, place a weight on the bar between the supports and shift it, until the cross hair cuts the original division on the rod. Measure again the height of the end of the bar above the floor, and the difference between these two measures in inches will be the deflection v. Putting these known quantities into the formula, we can compute the value of E for this bar; it will perhaps be 1,700,000.

If we wish next to experiment with a beam, supported at its ends, and carrying a single weight at any known distance from one support, we have simply to place the bar on the supports, put the mirror over one of them, get the reading of the rod as before, measure the height of the bar above the base, and then attach the weight. We can now measure the deflection at any point, can find its maximum value, the place where this occurs, and its agreement with theory. Then, by measuring the distance which the cross-hair has apparently moved on the rod and the distance from the rod to the mirror, we obtain the angle between the two incident rays, and by a law of optics the mirror has moved through half this angle. Hence we obtain the change of inclination over the support.

If the beam projects over one support we can attach a weight to the projecting portion, and bring the mirror back to its first position, when we shall have a beam fixed at one end and supported at the other. The product of this weight into its distance from the support gives the actual, to be compared with the theoretical, bending moment at the fixed point. By putting the bar on these supports we shall have a continuous beam of two spans, and the number of spans may be increased at pleasure. By two mirrors the beam may be fixed at both ends.

The weight of the bar is neglected, as the attached weights produce a definite change of inclination and of deflection for themselves, and all the measures are taken from the position assumed by the bar under the action of its own weight alone. By means of strips of lead or a row of blocks, the effect of a uniformly distributed weight may be tried. The theoretical formulæ may be found in any books treating of the flexure of beams. The experimental results will, with ordinary care, be very accurate and satisfactory.

[American Architect and Building News.]

ENGLISH BUILDINGS ON THE CENTENNIAL GROUNDS.

The English buildings promise to be among the largest, and in themselves the most interesting, at the Exhibition. They compose a group of three buildings, the largest one being intended for the commissioners' offices, while the others are to be used one as a kitchen, the other for the police force. They are half-timbered structures, their ephemeral character being shown by the filling that is used, which is neither of brick nor of stone, but simply of laths and plaster. The façade of the large building is occupied by three large gables, which express their construction with all possible frankness, and have that air of picturesqueness which is found in the old half-timber houses of Chester and other parts of England. The body of the building seems to be all window; for the casements of the rooms and corridors in the two stories are connected and form an uninterrupted line of windows.

The interior is attractively finished, great attention having been paid to the mantelpieces, which are of sculptured hard wood, fireplaces, stairway, and furniture. As might be expected, free use has been made of tiles—painted tiles for the fireplace jambs, enameled tiles for the hearths, encaustic tiles for the floors. There are two halls: one a kind of interior porch, the other a larger and more handsomely finished room, having at one end a large black-walnut mantelpiece, and from which the grand stairway ascends to the upper floor. A long corridor opens right and left from this hall, giving access to the various offices of the commissioners. In the upper story there are other offices for the commissioners, and a variety of smaller rooms appropriated to the use of the housekeeper and the domestics.

[Philadelphia Evening Bulletin.]

THE CENTENNIAL OPENING.

The Centennial Executive Committee has announced the programme for the opening exercises on the 10th of May. It is brief and simple, as it should be. With a musical introduction there will be prayer, a hymn, a cantata; President Hawley will report the Exposition as ready to the President of the United States, who will declare it open. And then there will be a salute of cannon and bells, and the grand "Hallelujah" of Handel.

The Executive Committee has acted wisely, in arranging the opening programme, in avoiding the American nuisance of an oration and other elaborate ceremonies, the chief purpose of which usually is to bring ambitious individuals into prominence, and the invariable effect of which is to bore audiences to death. The programme is admirably brief, and the talking is reduced to a delightful minimum. The orator of the occasion being President Grant, the "soul of wit" will preside over the opening of the Exposition; and that part of the exercises which the assembled multitude will be able to hear—the music—has been placed in hands which will insure a fine success. With a full chorus and orchestra, under the leadership of Thomas and Buck, the Centennial compositions are sure of a grand performance. The march of Wagner and the cantata of Buck and Lanier will be the musical novelties of the occasion, and neither of them could have been intrusted to more competent hands. The whole spectacle will be imposing from its republican simplicity, from the great concourse of the people who will witness it, from the grandeur of its splendid surroundings, and of the event which it signalizes. It will usher in a completed achievement, the like of which, under similar circumstances, the world has never seen, and, in all probability, never will see again. There have been other "World's Fairs" almost as grand as this; but none of them have expressed a great patriotic fact or sentiment. And there will be "World's Fairs" in the future that will surpass this; but none of them are likely to be, as this has been, the work of an unaided individual. Never again is it probable that one single member of a national family will step forward, Atlas-like, and bow its shoulders to the carrying of a burden such as Pennsylvania has borne alone in these few past years, and then step aside, in proud modesty, that others may reap the honors and benefits of her great devotion. Such anomalies in human history rarely repeat themselves; and this one is likely to stand forever alone as an illustration of individual patriotism and generous public spirit. The opening programme does not distinctively recognize Pennsylvania's work as such, and it would have been difficult for it to have done so. Pennsylvania has never claimed it as in any sense her own, except so far as the doing and the paying for it are concerned. And therefore the Executive Committee is right in making the occasion a purely national one. The General Government will be present in the persons of its chief officers, and the several States will be represented by their Governors and their Centennial Commissioners. Should the weather be propitious—and the selected season for the opening is a very safe one in this respect—we may expect to see one of the most imposing national demonstrations yet made upon American soil. Its popular proportions will be dwarfed into insignificance by the huge outpouring of the coming Fourth of July, but the opening of the Centennial Exposition possesses international features of peculiar interest, differing from and not affected by the national celebration of July. That will present scenes of its own such as the world has never yet looked upon, and to reproduce which will need the completion of another century.

CLOSE OF THE SUB-WEALDEN EXPLORATION.

Mr. H. Willet, the hon. sec., issued his quarterly report recently. He says: "Since I last wrote the Diamond Rock-Boring Company have succeeded in widening and lining the bore-hole to the depth of 1760 feet. After washing out the remaining 65 feet of the 2-inch portion (to 1825 feet), the actual boring was recommenced on Tuesday, February 8th. At 1826 feet the hard limestone passed into soft shales; at 1829 feet the laminæ were very numerous, as many as ten to fifteen per inch; at 1832 feet the shales insensibly became coarser and more granular; at 1841 feet I found a small perfect pecten; and from 1846 to 1849 feet imperfect fragments of ammonites were traceable. To an inexperienced eye the shales present much the same appearance as those which we have met at intervals for the last 1500 feet, and it is quite beyond me to say to what portion of the oolitic series they belong. Mr. Keeping, of Cambridge, considers that the cores at 1771 feet are decidedly those of coral rag, and if so we may now be in the Oxford clay." Mr. Willet says he has very little hope of a successful termination of the committee's labors, the conviction being irresistibly forced on his mind that the theory of the presence of a ridge of old rocks north of the English Channel and south of the Thames is no longer tenable, for a variety of reasons which he enumerates. He states: "I do not think the remaining 150 feet, making 2000 in all, will elicit any new facts to alter these conclusions. I therefore feel that it would be nothing less than imposture on my part to promote the extension of the bore at Netherfield beyond this limit. The same reasons, with greatly-increased force, on account of the different strata to be pierced, apply, in my humble opinion, to the whole remaining area of Kent and Sussex; and so certain am I of the correctness of my deductions, that I will undertake to pay, personally, the whole cost of a boring of 2000 feet if palæozoic rocks can be found by this process, commenced in any spot, either in the parish of Hythe or any part of Kent or Sussex above the Wealden horizon. If science means knowledge, the facts brought to light by the sub-Wealden boring must seriously modify the prior theoretic conclusions, right enough in themselves as possibilities, in the absence of such knowledge as we now possess. The attainment of this knowledge was the object sought for; its possession is my reward for four years of really arduous labor. I have been cheered and sustained in a marvelously unexpected manner by the undeserved confidence and liberality of those who have so readily subscribed to this the first boring for purely scientific purposes ever attempted in England."

THE ROTOMAHAUA GEYSER IN NEW-ZEALAND.

The hills all around the geyser teem with hot springs and hot mud in a liquid state, and constantly bubbling up and emitting a horrible sulphuric smell which is almost stifling. The great geyser itself is up in the top of a lofty hill, which appears to have been the crater of a volcano, now filled with light blue boiling water of an unknown depth. The water is forever seething and boiling, as if all the fires of perdition were aflame beneath it. It is constantly shooting up in columns from six to thirty feet in height, which sometimes look very beautiful when the sun converts the falling globules into showers of pearls and silver. The great geyser is approached from below by a series of crescent-shaped terraces, bowed outward, a few feet in height each, and perhaps one hundred yards in width, all overflowing till you come to the two principal terraces, the top one of which is always boiling over into those beneath it. The steam is almost blinding and suffocating when the wind is blowing towards you. In many of the pools there are pleasant bathing-places. The water is hot on the surface, but cool beneath, the boiling water from the great geyser above not seeming to penetrate far below the surface of the more distant terraces, which it overflows. There are two sets of terraces, the first of which are called the white terraces.

The rim around the boiling cauldron is formed of a white substance, like the most delicate filigree work, resembling lace, such is its regularity and beauty. This white rim, which projects some distance over the boiling fountain, shows to all the greater advantage because of the intense blue of the waters. These beautiful terrace-brims are formed by deposits of sulphur and silica from the boiling springs on the top of the hill, which pour down the sides and crush the tea scrub and other trees growing there, and form the incrustation. For, strange as it may seem, there is green grass and shrubbery to the very verge of the boiling fountains. Many of the basins appear to be made of petrified tea shrub or ferns. These brim-formations are very rough and sharp-edged, and very hard on boots or bare feet, though the Maories, whose feet are hardened, trip over them without any serious inconvenience. The water in all the terraces is beautifully clear and blue.

From the white terraces one enters a canoe and paddles over to the pink terraces, a short distance from the former. Their formation is the same as the first, but they are smaller, and instead of the pure white brim they have a pink-tinted border, which is exquisitely beautiful, and it is questionable whether they are not the prettier of the two.

RECENT METALLURGICAL PROCESSES.

In a very interesting paper on "Some Recent Metallurgical Processes," read before the Society of Arts by Mr. J. Arthur Phillips, it is remarked that among the most important of these may be classed those having for their object the extraction of gold and silver from pyrites containing small quantities of those metals, and to operations of this nature he has devoted a considerable portion of his time. It was, he said, remarked by Liebig more than a quarter of century since that the commercial prosperity of a country may be judged of with a great degree of accuracy from its annual consumption of sulphuric acid. Up to 1838 nearly the whole of this article was produced from Sicilian sulphur, but the monopoly then granted by the King of Naples to a Marseilles firm sent up the price of sulphur from 5*l.* to 14*l.* per ton, and manufacturers at once looked around them for some material from which sulphuric acid might be produced at a cheaper rate. This material was found in iron pyrites which, when pure, contains over 50 per cent of sulphur, and exists in almost inexhaustible quantities in various parts of Europe. At first the supply was drawn from Cornwell and Wicklow, and in 1842 Mr. William Longmaid patented a process which consisted in roasting ground iron pyrites with common salt in a reverberatory furnace, by which sulphate of sodium was produced, while any copper which might be present was transformed into soluble cupric chloride. The soluble salts were separated from the insoluble residue by lixiviation, the copper precipitated either by lime or iron, and sulphate of sodium crystallized out. In the specification of a second patent, in 1844, Mr. Longmaid stated he had discovered that there are circumstances under which, and situations where, ores containing copper, tin, and zinc with sulphur may with advantage be treated with common salt for obtaining the metallic parts, without depending mainly on the profits derivable from the sulphate of soda.

These inventions formed the basis of Mr. Henderson's improvements, patented in 1860, according to which it was proposed to obtain a large proportion of his copper by first volatilizing and subsequently condensing the cupric chloride produced. The amount of copper thus driven off is of comparatively little importance, but the employment of a condenser results in the collection of a considerable quantity of weak hydrochloric acid, which is advantageously employed for the subsequent lixiviation of the roasted ores. About 1859 Spanish and Portuguese pyrites had begun to find their way into the English market, and their treatment was carried on to a large extent, the consumption of burnt ore having risen from 192,000 tons in 1869 to 365,368 tons in 1875. It has long been known to those engaged in the extraction of copper by the wet process that the precipitate from Spanish and Portuguese pyrites not only contains a notable quantity of silver, but also a little gold. No successful attempt to separate these metals and to turn them to profitable account had, however, been made previously to 1870, but in that year Mr. F. Claudet discovered the process which is now generally adopted in establishments in which the recovery of the precious metals is effected.

The silver contained in the burnt pyrites, spoken of in the analyses as traces, usually exists in such minute quantities that its exact estimation is exceedingly difficult, but the results of a very large number of assays would go to show that the amount of silver present in a ton of ordinary burnt ore varies from 15 to 18 cwts.; at the present time, however, there are ores in the market which contain a larger proportion of the precious metals than that above indicated; these have, as yet, not been worked to any considerable extent. During the process of roasting the ground-burnt ores with salt a large proportion of the silver which they contain is converted into chloride, and this in the subsequent operation of washing is dissolved in the brine resulting from solution of undecomposed chloride of sodium. The vats or tanks in which the burnt ore is lixiviated receive some nine or ten successive washings, and of these the first three contain nearly 95 per cent of the dissolved silver. An analysis of a first washing from a copper vat, afforded (specific gravity, 1.24):

Contents per gallon.		Contents per gallon.	
Sodium sulphate	Grains 10,092	Lead	Grains 40
Sodium chloride	4,474	Iron	32
Chlorine, combined with metals	4,690	Lime	52
Copper	3,700	Silver	30.6
Zinc	480		

Arsenic, antimony, bismuth, etc., not estimated. Total chlorine, 7347 grs.=12,106 grs. sodium chloride. Total sulphuric anhydride, 5686 grs.=2274 grs. sulphur. Proportion of silver to copper, 10,000: 8.2. Washings 1 and 2 contain 82.50 per cent of total silver. Washings 1, 2, and 3 contain 94.30 per cent of total silver. The several operations employed for the recovery of silver are thus conducted: The liquors from the first three washings are run into suitable wooden cisterns, each having a capacity of 2700 gallons, where they are allowed to settle. The yield of silver per gallon of these liquors is now ascertained by taking a measured quantity, to which are added hydrochloric acid, for the purpose of keeping the copper in solution, potassium iodide, which converts the silver into an insoluble iodide, and lead acetate; thus determining a plentiful precipitation of lead salts, which take down with them almost the whole of the silver present. The precipitate obtained by these means is thrown upon a coarse ribbed filter, and after being roughly dried is fused with a mixture of sodium carbonate, borax, and lampblack. The resulting argentiferous lead is subsequently passed to the cupel, and from the weight of silver obtained the amount of that metal in a gallon of liquor is calculated. After the liquors in the settling-vats have been assayed they are drawn off into others of slightly larger capacity, while at the same time the exact amount of potassium iodide, or of some other soluble iodide, necessary to precipitate the silver present is run in from carefully graduated tanks, together with a quantity of water equivalent to about 1-10th the volume of the copper solution. During the filling of these tanks their contents are kept constantly stirred, and when full are allowed to settle during 48 hours.

At the expiration of this period the whole of the iodide of silver will have fallen to the bottom, and the supernatant liquors, after being assayed for silver, are run off to the copper-precipating vessels. The precipitate which collects at the bottom of the vats into which the standardized iodide has been introduced, is once a fortnight washed into a stowage-tank prepared for its reception. This precipitate chiefly consists of a mixture of plumbic sulphate, plumbic chloride, argentic iodide, and subsalts of copper, from which the latter are removed by hot water acidulated with hydrochloric acid. After being thus freed from copper salts the silver precipitate is decomposed by boiling with metallic zinc, which reduces the argentic iodide and plumbic chloride, etc. The results of these operations are: Firstly, a precipitate rich in silver, containing a small proportion of gold; secondly, a solution of zinc iodide, which, after being titrated, is employed in subsequent operations for the precipitation of further quantities of silver. An analysis of a fair sample of the dried argentiferous precipitate afforded the following percentage results:

Silver	5.95	Lime	1.10
Gold	.06	Sulphuric anhydride	7.68
Lead	62.28	Insoluble residue	1.75
Copper	.60	Oxygen and loss	3.62
Zinc oxide	15.46		
Ferric oxide	1.50	Total	100.00

This analysis shows that the whole of the iodide of silver had been completely decomposed with formation of zinc iodide, since not even a trace of iodine could be detected in the residue. The presence of gold in the precipitate, produced by the addition of a soluble iodide to the copper liquors, may be explained by supposing that a portion of this metal, which is known to exist in small quantities in the pyrites, is by calcination with salt converted into chloride of gold; this in the presence of large quantities of sodium chloride is not reduced by the temperature at which the charges are worked, and entering into solution at the same time as the silver, is precipitated with it by the iodine. At the Widnes Metal-Works, where the liquors resulting from the treatment of about 22,500 tons of burnt ore were worked by this process during the year 1875, the resulting auriferous silver was sold for 2600*l.*, which is equal to 2*s.* 3¼*d.* per ton on the burnt ore treated. The expense of treatment, including loss of iodine, labor, coals, wear and tear apparatus, etc., amounted to 500*l.*, thus leaving a profit of 2100*l.*, or 1*s.* 10¼*d.* on each ton of cinder operated on.

The process invented by Mr. T. Gibb, and adopted by the Bede Metal Company, is referred to, but it may be presumed that it is not successful, for it is stated that inquiries addressed to Mr. Gibb on the subject have elicited no reply. Mr. Phillips mentions that the proportion of silver recoverable from each ton of burnt ore—about 1 in 60,000—appears at first sight very small, but when we consider that no less than 365,000 tons of these residues are annually treated in the United Kingdom, its importance becomes apparent. If the whole of the silver and gold which could be extracted from the ore by Claudet's process were annually recovered they would represent a money value of at least 42,000*l.*, or a net profit of (say) 33,500*l.* Mr. Phillips then gave a description of the Hunt and Douglas process, and concluded his paper with a list of the firms treating burnt cupreous pyrites by wet extraction, together with the quantities worked respectively by each during the last three years.

In course of the discussion which followed the reading of the paper, the high price of iodide of potassium was referred to as a disadvantage, and Dr. C. Le Neve Foster asked whether Mr. Phillips hoped eventually to be able to apply the same process to the Cornish ores, which contained more silver than those spoken of, but were nothing like so uniform in composition, and contained other constituents, including arsenic and zinc. He had also heard of a process whereby the silver and copper were both precipitated at once by the aid of metallic iron, and he should like to hear Mr. Phillips's opinion upon it. It seemed they might be separated in solution; but the process was in use, and certain advantages were claimed for it, though he was not aware what they were.

In replying to the questions raised, Mr. Phillips explained that although iodine was expensive (8*s.* per lb.), the process was a cheap one because the loss was so small. The whole expense was about 5¼*d.* per ton of ore treated, including labor, and he did not think they could hope for any thing much cheaper. It had been asked why they did not precipitate with copper, but he thought that the questioner must have been dealing with sulphates if he had succeeded by that method. All he could say was that when you treated liquor containing cupric chlorides with metallic copper the result was a dirty paste of cupreous chloride, which looked more like brick-clay than any thing else. It did reduce the silver, but the chlorine was divided between the copper, and you got a wretched mass which was utterly untreatable. He recollected that at first some tried to use copper-pipes for blowing steam into the precipitators, but the result was they dissolved almost immediately, and seemed as if made of unbaked clay. It was possible, perhaps, under some circumstances to get cement copper to precipitate silver from chloride, but he had never been able to do so. You got it precipitated, no doubt, but there was so much chloride of copper with it that the silver was almost useless. With regard to Cornish ores, they contained about 6 oz. to 8 oz. of silver generally, and a large proportion of it could be got out, but the difficulty was, in the first place, there was so much arsenic in them, and the gangue was siliceous, so that you lost all the value as iron-ore, and consequently the only element of success was taken away—the sale of the material for making iron. Lead was frequently present, and all these things made the treatment so complicated that he was afraid they had yet something to learn before treating Cornish ores successfully. With regard to precipitating silver and copper together by iron, and running it out through shoots, the value of the silver was very much reduced in the presence of copper, so that only two thirds of its price could be obtained. If you got a copper precipitate containing silver it was bought up by sulphate of copper-makers, who oxidized it in a furnace, attacked it with sulphuric acid, and there was always chlorine enough to leave the silver behind. But you were very much in their hands as to what price they would give for it. The advantage of Claudet's process was that you got the full price for the silver, the full price for the gold, and 3*s.* per unit for all the lead. About 12*l.* per ton was charged for smelting, and they took off 3*s.* for every unit of zinc. The result was that you got paid for all the silver and all the gold, and the lead more than paid the fine upon zinc. In the other case you got nothing for the gold, and only two-thirds of the value of the silver. With regard to the quality of the copper, they got no more for the copper than they did before taking the silver out, and those who bought copper and refined it did not tell him it was at all better; still he found they could sell the precipitate at rather a better price, and if there were two lots in the market that freed from silver was generally preferred; besides which, they learned that the copper was improved, and that more than eight ounces of silver to a ton of copper very materially deteriorated its quality. In the other case there were 18 oz., which would make a considerable difference. Mr. Kenelly wished to ask Mr. Phillips, as he did not think Claudet's system was applicable to Cornish ores, if there was any other method of dealing with them. Mr. Phillips said he could not say that Claudet's process was not applicable, but hitherto they had not succeeded so well with it as they had hoped. The great reason why the process of precipitating the two metals together was not so successful was this, that they expected to get the aggregate value of the two metals; but this was not so, because they could not obtain so much for the silver mixed with copper as if it were pure or mixed with lead. The great difficulty in treating Cornish ores was to get a regular supply. You never got two parcels alike, and so you had to be constantly changing the process in order to treat them successfully. If you could get a large supply of something like a constant composition you might work it, but with small quantities of ever-varying ores you had to be inventing a process for every fresh charge you put in.

[Engineering and Mining Journal.]

THE INFLUENCE OF COAL-DUST ON THE EXPLOSIVENESS OF FIRE-DAMP.

The actual conditions which may affect the explosiveness of fire-damp or any of the exceedingly variable hydro-carbon series are but little understood. We know, by experiment, that the illuminating power of common coal-gas is greatly increased by increasing the temperature under which the combustion takes place, and there is a probability that the very composition of the gas, in the act of combining with the oxygen of the air—in burning—may vary to an important degree, with different conditions of temperature, etc., under which the combustion takes place. An important series of experiments has recently been made by Mr. W. Galloway, Assistant Inspector of Mines in South-Wales.

He has found that a mixture of air and fire-damp, which could not be ignited by a naked lamp, becomes inflammable on introduction of coal-dust. If fine dry dust be mixed with air, a very small percentage of fire-damp is sufficient to render the mixture dangerous. It appears, therefore, that the clouds of coal-dust raised by a slight colliery explosion or by blasting in the coal, may be a source of great danger by conferring inflammability on air which is contaminated with fire-damp, but not otherwise inflammable.

This important observation may explain some of those mysterious explosions resulting from shot-firing, when the mine was supposed to be entirely free from gas. Its mere mention will be sufficient to put on their guard those in charge of collieries producing fire-damp, and the fact, if as stated, will be an additional reason for prohibiting shot-firing in such mines. The manner in which the coal-dust promotes the explosiveness of the gas is not explained.

Many of our readers will remember the report of a very peculiar explosion that occurred in a flour-mill in England a few years ago. This explosion took place within the chamber containing the stones, and was so violent as greatly to injure the machinery and buildings; distinguished scientists who investigated the matter at the time, attributed the phenomena to the "explosion"—in other words, to the rapid combustion of the flour-dust in the stones, which became ignited by some accidental means. Thus it appears flour-dust may burn so rapidly as to be practically explosive, and in the combustion of pulverized fuel—the elaborate experiments on which have lately been described in the pages of this journal, by the talented gentleman who conducted them, Chief-Engineer Isherwood—the combustion of coal, and even of anthracite, reduced to the condition of impalpable powder, is so rapid as to be capable of developing in a confined space all the phenomena of explosion. We therefore see nothing either very new or at all improbable in the suggestion that coal-dust may be the cause of explosive phenomena under favorable conditions, and if the atmosphere in which its combustion takes place is already almost explosive, the conditions suitable to the more rapid combustion of the coal are favored; hence even without calling in the aid of any elaborate chemical theory, we may explain the phenomenon. Its practical bearing will be readily appreciated.

The production of precious metals in the United States from 1848 to 1875 amounts to the enormous sum of over $1,582,000,000, of which nearly $1,300,000,000 came from gold. Last year the yield of the great West, including western Mexico and British Columbia, was upwards of $80,000,000, over six millions more than the yield of 1874. The estimated product for 1876 is $90,000,000.

In his annual report, the general superintendent of Wells, Fargo & Co. gives the following tabulated report of the yield for 1875:

States and Ter.	Gold Dust and Bullion by Ex.	Gold Dust and Bullion by other conveyances.	Silver Bullion by Ex.	Ores and base Bullion by Freight.	Total.
Califor'a	$14,842,010	$1,484,301	$362,668	$1,069,172	$17,758,151
Nevada	196,858	19,685	35,283,193	4,978,633	40,478,369
Oregon	730,133	435,913	....	....	1,166,046
Washing'n	74,517	7,415	....	....	81,932
Idaho	1,163,698	116,329	230,875	44,000	1,554,902
Montana	2,225,609	500,000	98,000	750,000	3,573,609
Utah	43,686	4,368	764,041	4,875,399	5,687,494
Arizona	23,500	....	....	85,593	109,093
Colorado	2,627,444	....	2,610,266	1,062,107	6,299,817
Mexico	68,117	....	1,716,184	624,370	2,408,671
Br. Col.	1,615,412	161,541	....	....	1,776,953
Total	$28,649,984	$2,699,492	$41,080,987	$13,459,274	$80,889,087

OILS USED IN LUBRICATING MACHINES.

E. and G. Dollfus.

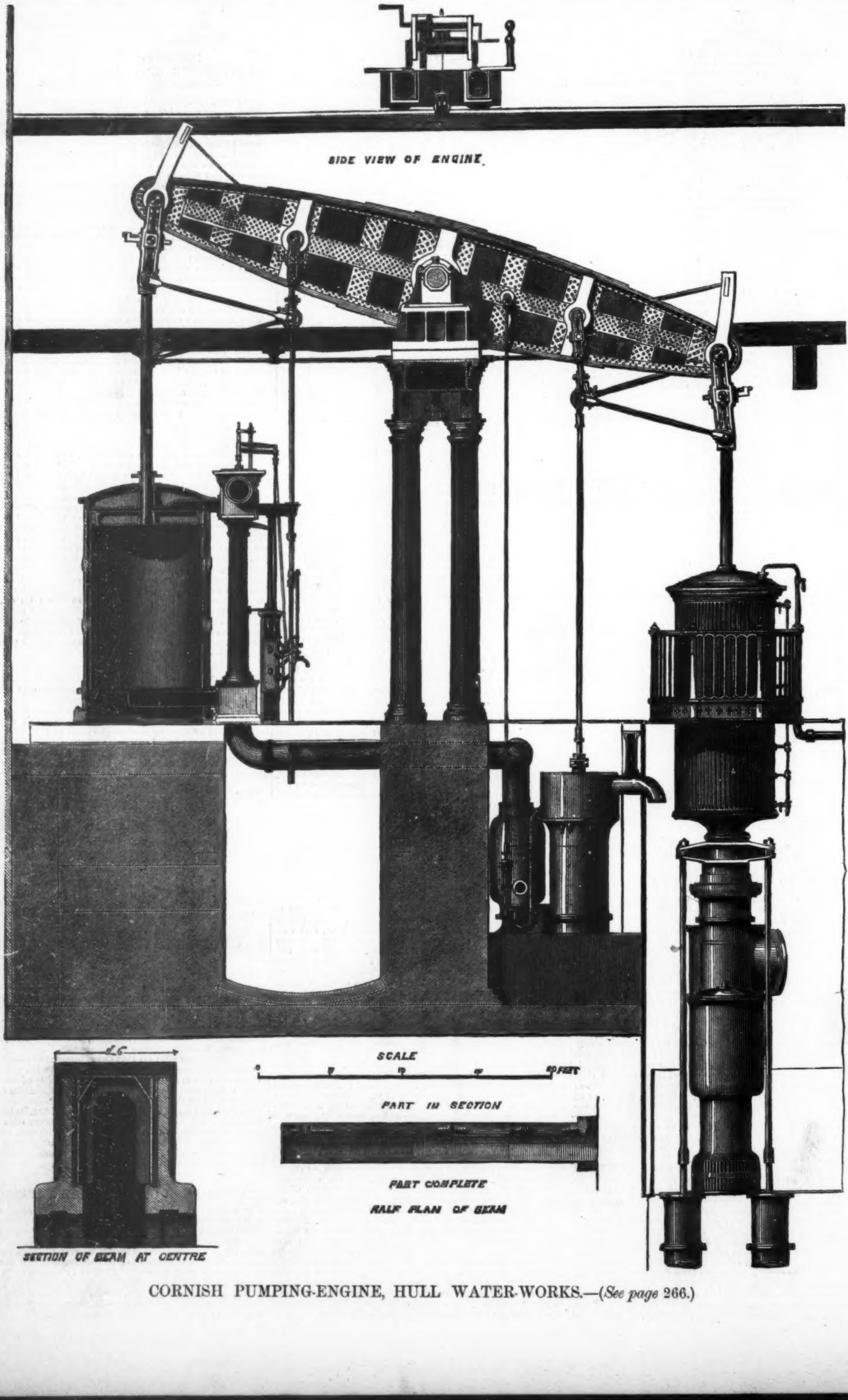
By distilling crude petroleum with the aid of a current of superheated steam, an oil, distilling over between 300° and 350°, and having a flashing point of 220° or over, was obtained, and this, under the name of "oleo-carbure," is recommended for mixture with vegetable or mineral oils. The claim with regard to spontaneous inflammability is that the mineral oil resists oxidation, and that, therefore, waste impregnated with it will not ignite spontaneously.

The conclusions are: (1) that the admixture of oleo-carbure increases the viscosity of the lubricating oils with which it is mixed, (2) that it diminishes the inflammability of the lubricator, and (3) that the lubricators made by admixture of oleo-carbure are less liable to turn rancid.

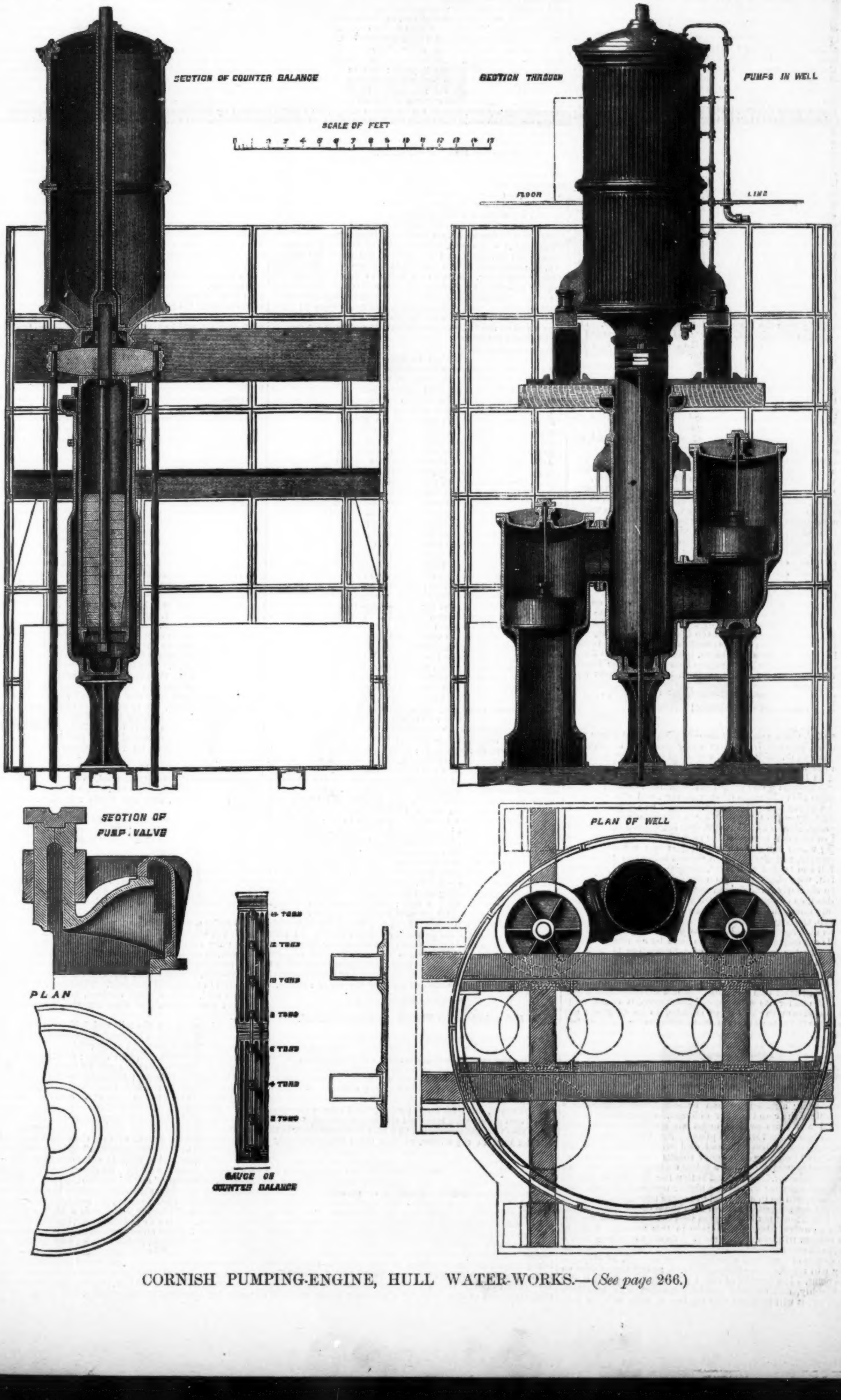
On the other hand, the cost of the oleo-carbure, its tendency to separate out from its mixtures, and its strong odor which might be prejudicial to the health of the workmen, are mentioned among its disadvantages. The committee recommend an award, but express their belief that the conditions required for the prize have not been met.

MANUFACTURE OF ALUM UNDER PRESSURE.

In reply to a question whether the temperature of a mixture of sulphuric acid and clay will not be raised by the direct introduction of steam, Dr. M. Faudel says: "I hold the direct introduction of steam into a mixture of sulphuric acid and clay improper, because condensed water is thus obtained, and the weakened sulphuric acid consequently can not work so effectively upon the clay. All that is necessary is to envelop the closed leaden vessel in a cover, into which the required quantity of steam is blown in. The closed leaden vessel can also be heated to a certain degree in a paraffin bath; the effect will be the same."—*Papier Zeitung.*



CORNISH PUMPING-ENGINE, HULL WATER-WORKS.—(See page 266.)



CORNISH PUMPING-ENGINE, HULL WATER-WORKS.—(*See page* 266.)

[Engineer.]

PUMPING-ENGINE FOR THE HULL WATER-WORKS.

[See Cuts on pages 264-5.]

For some time past, works have been in progress for providing Hull with a better supply of water than it has hitherto possessed. On the 13th of August, 1873, Messrs. Smith, Pender & Co., of Millwall, took a contract for the erection of the requisite pumping machinery, which present certain features worth attention. The most important portion of the contract consisted in the putting down of a pumping-engine of 250-horse power nominal, the cylinder being 90 inches in diameter, with a piston stroke of 11 feet, at Springhead, some four or five miles from Hull, of which engine we give drawings. The manner in which the pumps are arranged is so clearly shown in our engraving that no minute description is required. Only one set of pumps is at present in place, but provision has been made, as shown by the dotted lines, to introduce others when required. The suction lift is 22 feet, and the head against which it is possible the engine may have to pump is 200 feet. The actual weight of lift against which it is now working being something less than this. The beam is of wrought iron, 40 feet long between centres, and weighs nearly 40 tons. It is carried by the entablature, a massive casting, which in turn is supported by four cast iron fluted columns. At the outer end of the beam is the plunger, from the crosshead of which two rods are carried for working the lift-pumps. These pumps are 27 inches in diameter, lifting the water half way up the shaft into a large wrought iron tank, from whence it is forced by the plunger, which is 37 inches in diameter, into the main pipes extending to the Stoneferry reservoirs, a distance of nearly five miles. The water is then pumped by the engines at Stoneferry from the reservoirs into the town of Hull. The new engine at Springhead, however, has been constructed to pump when required direct into Hull as well as into the Stoneferry reservoirs. As a greater pressure is required to pump into Hull direct than into Stonehead, a large cast iron ballast-box, weighing 17 tons, has been placed on the plunger crosshead, into which a pipe is led from the main; this pipe works through a stuffing-box in the cover of the box while the engine is in motion. When necessary to pump direct into Hull this box is filled with water by means of the pipe, increasing the weight at the plunger end of beam 14 tons. For Stoneferry pumping this weight of water is run off, and the engine allowed to work with the empty ballast box, which has been found quite sufficient for this light pumping. The engine has been constructed to pump against a maximum pressure of 200 feet, and a minimum of 130 feet of water.

The well from which the water is drawn is 22 feet in diameter and 73 feet deep; the sides are lined with cast iron in ten segments to the circumference. Half way down this well is a wrought iron tank to receive water from the lift-pumps. This tank is fixed on two wrought iron girders, and contains the main force-pump. Overhead, and close to the roof in the engine-house, are two powerful traveling cranes running the extreme length and breadth of the building, and capable of lifting 20 tons each. The steam for the engine is procured from three cylindrical boilers 7 feet in diameter and 30 feet long, in the old boiler house.

The general finish of the engine reflects credit on the makers. We shall watch the performance of this engine with some interest, as a comparison of its duty with that done by the rotative engines of some of the London water-works, with the Cornish engines on deep pit work, and the compound differential engines of Messrs. Hathorn, Davis & Co., can not fail to prove instructive, the Hull engine being one of the largest true Cornish engines ever put down to work without long pumping spears.

[Engineer.]

CLOTHING FOR BOILERS.

One of the best possible systems of clothing the upper portion of a Cornish or Lancashire boiler consists in turning a brick arch 4½ in. thick over it, a space of 3 in. intervening between the soffit of the arch and the boiler-plates. The bricks should be laid in clay, not mortar, and the ends should be carefully stopped up by arched plates of iron, cast to shape. The joints are to be made tight with clay, and the whole or any part of the structure can be removed and replaced very expeditiously when the boiler needs examination. This arrangement, simple as it is, is obviously inapplicable to a marine boiler, or that of a locomotive or portable engine. Again, the clothing which will suit a marine boiler will not answer for a locomotive, and *vice versâ*. A marine boiler can be clothed with felt and lagged with wood, covered, where any sea-water may fall, with sheet-lead. In a few cases locomotive boilers may be similarly protected, sheet-iron being substituted for sheet-lead, as the outer coating of all; but, as a rule, felt and wood are unsuitable for the modern locomotive, the pressures in which, and consequently the temperatures, being so high that the felt undergoes a rapid process of deterioration, and the wood is carbonized. It was at one time by no means a rare accident for the lagging-boards of a locomotive to take fire and burn away fiercely. In the present day, however, some one or other of the numerous boiler-coating compositions in the market is used, the cement or mastic being finished off neatly with sheet-iron and paint. When the conditions under which the boiler has to be worked are known, it is not difficult to decide on the system of clothing to be adopted; but this is not the case as regards the material to be used, and it is on this point that the greatest diversity of opinion exists. It should carefully be borne in mind, although it is constantly forgotten, that whether the protective material is or is not a first-rate non-conductor, unless its qualities as a non-radiator are also good it can not prove wholly satisfactory. Under ordinary circumstances, about 75 per cent of the heat which an unprotected boiler loses is lost by radiation, very little opportunity being afforded for loss by conduction. As regards locomotives the case is rather different, because fresh bodies of cold and more or less moist air are being continually brought into contact with the plates. For the moment, however, we may neglect this, and deal with stationary boilers alone. It is obvious that, other things being equal, a bad conductor of heat will make a better coating for a boiler than a good conductor. The reason is that the exterior laminæ of the good conductor will have a higher temperature, and, consequently, will be in a position to radiate more heat in a given time per square foot of surface than those of the bad conductor but it must not be supposed that the bad conductor can claim an overwhelming advantage in this respect. Many of our readers will, we fancy, find it difficult to believe that a couple of coats of good whitewash will as effectually prevent the escape of heat from a boiler-plate as an inch of clay. If they will try the experiment they can satisfy themselves on this point. If a coating of clay 1 in. thick be suffered to dry thoroughly, and be then carefully blacked with moulder's blacking, it will be found that the loss of heat will be very great. In certain cases very anomalous results have been obtained from various boiler-coatings. A given mastic has answered very well at one mill and very badly at another. It will usually be found on examination that in one mill the coating has been whitewashed, and in another blackwashed. The loss of heat from a black dull surface by radiation being 100, that from polished metal does not exceed 5. It must not be forgotten, however, that color alone may not affect the radiating power of a material, as white-lead paint radiates heat almost as fast as black paint; and in the same way whitewash is a very much better radiator than polished metal of any kind, although far less active in this respect than lampblack. A great deal appears to depend on the texture of the radiating surface, but, so far as we are aware, no experiments worth the name have been tried, the results of which could render a knowledge of this fact useful as regards steam-boiler coatings. In other words, it is not known what is the best kind of surface for a boiler-coating.

With the experiments of Tyndall on heat no doubt most of our readers are familiar. The investigations of Peclet have also taught engineers a great deal worth knowing, but there is still room for further experiments on a really practical scale. Peclet has shown that of all the materials that could be used for clothing a boiler, nothing is in one sense better than gray blotting-paper, the quantity of heat transmitted per square foot in one hour by a block of this material 1 in. thick being only .274 of a unit, while a plate of copper 1 in. thick transmitted 515 units, and one of iron 233 units per square foot, the difference in temperature at the opposite sides of the plates being 1 deg. It is to be borne in mind that we are dealing here with conduction only, not radiation. Paper does not appear to be well adapted for boiler-work, but powdered chalk is an admirable non-conductor, and could often be used for the purpose. It would be impossible here to give in detail even a few of the more important results obtained by Peclet. Those of our readers who care to go further into the subject will find them summarized in the excellent little "Treatise on Heat," by Box, published in 1868. In 1859 a somewhat carefully conducted series of experiments was carried out at Mulhouse to determine the value of various materials in preventing the loss of heat from steam-pipes. A paper on the subject was read before La Société Industrielle de Mulhouse. An abstract of this paper will be found in English in the "Journal of the Franklin Institute" for March, 1875. Without going into detail, we may state here that the experiments were made with five groups, consisting each of four cast-iron pipes nearly 4¾ in. diameter and ½ in. thick. The total surface exposed was 58.47 square feet per group. The pipes were parallel to each other and 39 in. apart. Four of the groups were covered with the various materials to be tried, the fifth being left bare for comparison. The first group was protected with straw to the thickness of 0.6 in. laid lengthwise, and secured by bands of straw wound spirally round the pipes. In the second group the pipes were bare. In the third, hollow earthenware tiles were strung on the pipes, an annular space being left between the metal and the pipe. The pipes were coated with clay and chopped straw held on by straw bands. In the fourth group the pipes were protected by a thickness of one inch of cotton held in place by a wrapping-cloth and string. The pipes in the fifth group were protected with Pimont's composition, consisting apparently of clay and cowhair kneaded together. This was built on with slips of wood to a thickness of 2.36 in. The steam pressures varied between 1.5 lb. and 15 lbs. on the square inch. In some of the experiments the Pimont coating was left of the natural brown color; in others it was painted white.

The result of the experiment was that the bare pipes, with a difference of temperature of 193.2 deg. Fahr., condensed per hour per square foot of surface .584413 lb. of steam of 22 lbs. absolute pressure. With the clothed pipes it was found that the first group condensed per square foot per hour 0.200382 lb. The bare pipes in group 2 condensed 0.581267 lb.; the third group, 0.228878 lb.; the fourth group, 0.286106 lb.; and the fifth, or plastered, group, 0.324070 lb. Roughly speaking, the relative merits of the various systems stand thus: Uncovered pipes, 58; straw, 20; pottery, wrapped with straw, 22; cotton waste, 28; plaster, 32. Experiments were made, as we have stated, to test the influence of color. In two experiments it was found that by painting the plaster white its efficiency was brought up to 26, and the average showed that while the condensation when the plaster was brown was 0.324070, it was when white 0.307229—a fact which bears out the statement we have already made to the effect that color may exercise an important influence on the efficiency of a boiler-coating. Without going deeply into the subject here, it may be stated that the best material for preventing loss of heat was straw, which reduced the loss by 66.5 per cent. The next best was the pottery-pipe arrangement, which saved 61.5 per cent; next some old felt, which had been treated with caoutchouc with a saving of 51 per cent; next came the waste cotton, ;this saved 48 per cent; lastly came the Pimont plaster, which saved 45.2 per cent when painted white; from which appears that plaster made of clay is not the best material that can be used for protecting a steam-boiler. In point of fact, as far as conduction goes there is nothing like an air-space for retaining heat. When this can not be adopted, cements or felts, etc., must be used; but much information is wanting as to how far the relative efficiency of these materials is affected by the character and color of the outer surface.

SMOULDERING FIRES IN COAL-MINES.

At a meeting of the Manchester Geological Society, held on Tuesday, at the rooms of the Literary and Philosophical Society, George street, Manchester, Prof. Boyd Dawkins in the chair, a discussion arose as to the probable connection between smouldering fires in goafs in coal-mines and mine-explosions. Mr. Greenwell observed that about 80 per cent of the explosions took place between the months of November and February, but they knew perfectly well that in the working of coal gunpowder was used all the year round, and they knew also that the ventilation as a rule was more slack in the summer than in the winter, so that there was apparently a greater probability of explosions taking place in the summer than in the winter, but yet they found quite the reverse to be the fact. The question was how was this to be accounted for, and whether there was not a possible connection between these explosions and the standing or smouldering fires in the goafs. Was it not possible that where there happened to be a standing fire in a goaf that in the summer-time, owing to the less active state of the ventilation, it was kept down in a smouldering condition that would not ignite the gas should any happen to be present, but that in the winter, when the ventilation became more active, there was a possibility of its being fanned into such a flame as would ignite the gas and thus cause an explosion? He suggested that it would be a very useful thing if they could collect together some information, statistical or otherwise, by which they might arrive at a conclusion as to whether there might not be some connection between the explosions which took place and standing fires. He knew several cases in which explosions took place through fire which was standing in a goaf. If the quantity of gas had been large instead of small there was no physical reason to prevent a very heavy explosion taking place instead of a series of slight ones. Such might possibly have been the case in the Oaks explosion. Mr. J. Dickenson, Inspector of Mines, said that in almost all cases the cause in large explosions had been distinctly traceable. In the Oaks explosion it was clearly owing to the pressure of a large quantity of gas in the mine, and an excessive charge of gunpowder having been fired when the mine was in that condition. A paper was to be read by Mr. Thompson before that society at the next meeting which would no doubt contain some valuable information with regard to this question.

[Paper Trade Journal.]

BLOTTING-PAPER MANUFACTURE.

There are few kinds of paper which are more difficult to make than blotting. There are several different varieties, from the very thin blotting to the thick "pad," which are made in various colors, but the demand is mostly, at present, for pure white. One very excellent grade of blotting is imported from England. One side of it is very smooth for printing purposes, and the other is rougher, although both sides can be used for blotting.

Of late years a number of mills in this country have undertaken the manufacture of this class of paper with more or less success. The chief characteristics of a good blotting-paper are great absorbing capacity, and that it will not harden while in use. To produce a paper which will possess these qualities, it is necessary, in the first place, to work the proper kind of stock, and to give it peculiar treatment, especially in the engines.

The manufacture of "thin blotting" will be first described. In selecting the rags, sort out all the linens very carefully, as well as all of the newer and harder cottons, reserving only the very softest and most tender cottons. Prepare for the engines by boiling in the usual manner. Before proceeding further it is absolutely necessary that the washer and beaters should be in proper condition. To this end, one washer and two beaters, carrying about 300 pounds each, should be well sharpened, the washer-plate in the usual way, and the beater-rolls "chipped," and two sharp plates put in. "Chipping" or sharpening the beater-rolls is done with a cold chisel and hammer, and should be done very thoroughly, as sharp "tackle" is very necessary to produce the proper results. In washing, keep the roll up until the rags are pretty well washed, then let it down and get stock into half stuff as soon as possible. Bleach and empty into the drainer. In making pink blotting, "Turkey reds" may be used. Wash them quickly and empty into a second drainer. In furnishing beaters, use about three quarters bleached rags and one quarter "Turkey reds," and beat off in about two hours. "Turkey reds" and such colored stocks are very seldom to be had nowadays, and in making colored blotting any desired color can be produced in the usual manner, and with materials such as are used in other papers. The amount of thin blotting used in this country is small at present.

Thick blotting, say 19 x 24, 70, 80, 90, 100, 110, and 120 pounds to the ream, can be made out of the same class of stock just mentioned. In treating it in the engines, however, there should not be more than half as many bars in the beater-roll as in making thin blotting. A small 250-pounds engine should have about thirty-six bars in the roll and fourteen knives in the plate. The bars and knives should be sharp, but if the roll is too fine the paper produced will be hard, like heavy book water-leaf papers. When making 100, 110 and 120-pounds paper, beat only one hour, and somewhat longer for the lighter weights. It is often quite sufficient to prepare only one beater in making heavy blotting, as by beating so fast the machine can easily be supplied. Since the principal work in making this class of paper lies in treatment in the engines, these should be in charge of a very competent engineer.

Blotting-paper should be made on a Fourdrinier machine, and the shake should not be used, so that the fibres may not be felted too closely together. The suction on the boxes should be strong, and the couch roll should be run very light.

Cotton waste is worked very successfully by some mills into blotting-paper. Working it into blotting, some paper-makers think it best to sort out all the "thread waste," using nothing but the soft cotton.

What has been said above in regard to treading rags in the engines for blotting-paper, applies with all the more force to cotton waste, as this stock is so much stronger than rags. If the engines are not in the condition as directed, it is useless to undertake to make a good blotting-paper out of cotton waste.

To make a perfectly clean white article of heavy blotting-paper the waste should be carefully sorted. The boiling is also very important, and with proper treatment in the engines, as explained in this article, the manufacture of blotting becomes a comparatively easy task. A mill undertaking it, however, should have a force of intelligent help, from the rag-girls to the machine-tender. The writer of this article, as before said, prefers small engines, but those carrying 600 pounds are successfully used for this purpose in several mills.

The following are the mill and jobbing prices of some of the principal brands of blotting-paper made in this country: "Treasury," mill price, 21 cents; jobbing price, 23 cents. "Commercial," mill price, 18 cents; jobbing price, 20 cents per pound. These two are made by one concern. "Mercantile," mill price, 16 cents; jobbing price, 20 cents per pound. Another brand has lately been introduced, called "Excelsior," and it is sold to the trade at 15 cents per pound. It is a very good paper. Several Western mills and one Southern mill occasionally turn out very good specimens of blotting-paper.

Among foreign papers of this class now being offered in this market is the "Homogeneous." This is certainly a most excellent paper, and is dark in color on one side, and lighter and smoother on the other. Its absorbing qualities are quite equal to "Treasury," and it is sold to the trade at 22½ cents per pound. A first-class article of English heavy white blotting sells for 21 cents per pound to the trade. It will thus be seen that "Treasury" blotting commands a higher price than any other brand. It is an excellent paper, but like Faber's pencils and David's ink, the large demand for it is based upon a long established reputation rather than on any intrinsic superiority over other makes of blotting. Manufacturers of the various brands of blotting now before the market can largely increase the sale of their specialties by making their merits better known, and, in the end, can establish a very high reputation for American blotting-papers.

THE MECHANICAL ACTION OF RADIATION.

By LEROY C. COOLEY, Ph.D.

[Read before the Albany Institute, February 1, 1876.]

THE motion of light bodies under the influence of radiant heat and light seems to have been noticed, independently, by several observers, at long intervals during the last half century, but only within the half decade just past can it be said to have gained a place among the phenomena of acknowledged interest in science.

In the *Edinburgh New Philosophical Magazine* for 1828 is a record of what seems to have been the earliest experiments on this subject. They were made by Mr. Mark Watt, and I quote from his interesting paper the following description of the first instance of a light body indicating, by its motion, the impression it received from the sun's rays. "Twelve or fifteen magnetized sewing needles were stuck into a thin circular slice of cork an inch in diameter, at a distance of one sixth of an inch from each other. The heads of the needles were so fixed into the piece of cork that they stood perpendicularly and all the points, being south poles, stood uppermost. The cork was then placed on the centre of a surface of water 1½ feet in diameter. The needles, in this situation, being prevented from evincing any polar attraction by their perpendicular position, were attracted by a moderate degree of light, heat, or electricity, but were repelled by the more powerful impulses imparted by the concentration of any of these bodies.

After the elapse of twenty years the phenomenon seems to have been rediscovered by Mr. Mitchel. A description of his experiment may be found in the first chapter of *Dick's Practical Astronomer* (see also *Scientific American*, vol. xxxiii. 9), and reads very much as follows:

A p ate of very thin copper, an inch square, was fixed upon the end of a fine wire ten inches long. A very delicate magnet was fastened to the middle of the wire and the whole, balanced on a pivot, was enclosed in a glass case. The rays of the sun, collected by a concave mirror of two feet diameter, were thrown to a focus on the copper plate. The plate began to move under the influence of the condensed sunbeam, and in about two seconds it had traversed as many inches and struck against the side of the box. This experiment was made with a view to prove that "Light, though exceedingly minute, has a certain degree of force momentum."

Many years later—it was in 1863—the energy of radiation seems to have revealed itself anew to the eminent Prof. Joule. "By means of a cylindrical glass vessel, divided in a vertical direction by a blackened pasteboard diaphragm, which extended to within one inch of the cover and of the bottom of the vessel, and in the upper of which spaces was delicately suspended a magnetized sewing-needle furnished with a glass index, he was able to detect the heat from a pint of water heated to 30° C., placed in a pan at nine feet distance; also that of a moonbeam admitted through an opening in a shutter as it passed across his apparatus." This description is extracted from a lecture by the Earl of Rosse on the heat of the moon, given at the Royal Institution in May, 1873.

In April, 1873, ignorant of all these earlier observations, I read, in this room, a paper on "Convection applied to the Detection of Heat," showing that a delicately-suspended needle would move in obedience to slight changes of temperature in any body brought into its vicinity, and describing a *Thermoscope*, quite sensitive, acting on this principle (*Journal Frank. Inst.*, vol. lxvi. 343). Further experiment soon afterwards resulted in the construction of an instrument so sensitive that the needle would swing in response to the heat radiated from the face of a person sitting at a distance of thirty feet (*Jour. Frank. Inst.*, vol. lxvii. 408). The form of instrument finally adopted, and used also in experiments to be described in the sequel, may be briefly described as follows: In a chamber whose walls are, to a considerable degree, impervious to heat, a glass thread, very long and very light, is suspended horizontally by means of two parallel silk fibres eighteen inches in length. One end of this a slender needle carries a small vertical disk of paper. The small end of a conical metallic reflector passes through the wall of the chamber, and its opening is covered with a piece of thin, partially-charred paper. The radiations from any distant source of heat are concentrated upon this scorched paper by the reflector. The needle-disk is on a level with the lower part of this paper, and moves toward or from it under the influence of every change of temperature it experiences, approaching if it be warmed and receding if it be very gently cooled, but approaching when the reduction of temperature is considerable.

In the meantime Dr. William Crookes, "while weighing heavy pieces of glass apparatus in a chemical balance enclosed in an iron case from which air could be exhausted," noticed that "when the substance weighed was of a temperature higher than that of the surrounding air and the weights, there appeared to be a variation of the force of gravitation." His first paper was sent to the Royal Society in May, 1873. "Experiments were thereupon instituted with a view to make the action more sensible and to eliminate sources of error."

By ingeniously devised apparatus Dr. Crookes was able to subject light bodies to the action of radiant heat and light in a vacuum perfect, doubtless, beyond precedent. While the exhaustion proceeded he found the motion of his slender balance-beam to be towards the source of heat, until, a very high degree having been attained, the motion *turned the other way*, the light body receded from the source of radiation as if driven by a delicate repulsion. (See *Quarterly Journal of Science*, 1875.) His second paper communicated to the Royal Society the interesting discovery of the mechanical effect of radiation in a vacuum, and *Repulsion by Radiation* is a phrase describing a new-found fact in physical science for which we are indebted to this capital research of Dr. Crookes.

These experiments of the English scientist, pronounced, by the President of the Mathematical and Physical Section of the British Association, to be among the most interesting in the whole range of physical science, have attracted much attention to the phenomenon. Prof. Dewar in Scotland and Herr Neesen in Germany have made valuable additions to the experimental data.

Prof. Dewar employed a novel means of obtaining the necessary vacuum. When the pump refused to reduce the tension of the rarefied gas, the residue was removed and the vacuum perfected by the absorbent power of charcoal. The vacuum thus obtained, like that of Mr. Crookes, forbade the passage of the induction-spark, and so sensitive was his instrument that "an ordinary lucifer-match held at a distance of four feet produced instant action, which was observed by means of a telescope." (*Nature*, xii. 217.) Of his results more is to be said as we proceed. Herr Neesen's apparatus consisted of a rectangular case of sheet-iron with an aperture in one side closed by a glass plate near to which hung a small and delicately-suspended mirror. The radiations were received by the glass plate, through which they passed to fall upon the mirror beyond, and the mirror was compelled to turn in obedience to their influence. (*Nature*, xiii. 10.)

By the experiments of these several observers it is well established that very light and mobile bodies are affected quite differently by radiant heat or light according as they are suspended in air or in vacuo. *Attraction* in air and *repulsion* in vacuo, are the terms employed by Mr. Crookes to describe these effects. These terms are convenient, but unobjectionable only when we use them to indicate the *direction* of the motion and not to describe the nature of the forces acting to produce it.

Of the nature of these forces views are not yet in accord. Mr. Crookes considers the air-current theory as altogether incompetent to account either for the attraction or the repulsion, but awaits the accumulation of all the facts before attempting to explain any of them. Professor Dewar regards the *heating of the movable disk* as the cause of the motion. He is reported as saying that "While the action takes place in air of ordinary density it is probably due to air currents" but, from the report, he seems not to have based this opinion upon any direct experimental proof. Nor does he allow the repulsion in vacuo to be due to any new forces of repulsion: he attempts to refer it to the molecular energy of the minute residuum of gas still left in the most perfect attainable vacuum. "What takes place," he says, "is this, the particles are flying in all directions with velocity depending upon the temperature. When they impinge against the heated disk their velocity is increased. They go off with a greater velocity than those which go off from the colder side, and hence there is a recoil of the disk." And this recoil, he thinks competent to put the disk in motion even in his excellent vacuum, "where we know that the exhaustion has reduced the density to $\frac{1}{4000000}$ of its original."

Professor Osborne Reynolds claims that whenever a surface imparts heat to a gas, there must be a reaction of the gas against the surface. A surface free to move would be propelled by this reaction. Moreover in a vacuum this motion would encounter less resistance and hence would be more conspicuous, as if it were due to a stronger force. Repulsion in vacuo, according to this view, is the effect of this gaseous reaction. (*Nature*, vol. xii. 405.)

If others have engaged in the investigation of this interesting subject, their work has, down to the present time, escaped my attention.

In July, 1875, I read a paper before the *Poughkeepsie Society of Natural Science*, giving a synopsis of several series of experiments, some of which were made before the publication of Mr. Crookes' remarkable discovery, but many of them afterward, with a view to determine the nature of the force as far as the so-called attraction in air is concerned. (*Jour. Frank. Inst.*, vol. lxx. 134.) The points then made are these: 1st. The motion of the needle having proved to be, under a great variety of conditions, exactly what air-currents are competent to produce, we may justly infer that it is due to convection. 2d. If this motion shall cease to occur when the air is removed (and Mr. Crookes has proved that it does), the evidence in favor of convection is complete.

Whatever may be the nature of the repulsion in vacuo, convection will, doubtless, in the end, be admitted to be the cause of the motion in air. The two motions are, I am persuaded, altogether distinct phenomena manifestations of two antagonistic forces, the repulsive being the more delicate and able to produce its effect only when the overwhelming power of convection currents is overcome by perfecting the vacuum.

But there is another phase of this curious action which seems to have escaped the notice of former observers. It may be described as *repulsion in air*. The application of a very gentle heat will, under certain conditions, drive the disk away from the warmed surface, even in air of ordinary density.

At intervals, from the time of my earliest experiments, this puzzling motion would thrust itself before me until I was convinced that it was not an experimental accident but that it was a legitimate effect of some rare combination of conditions. What these conditions are I set myself to discover.

It was an effect which I could not, at first, produce at will. Sometimes it would appear in the early morning but refuse to be reproduced as the day advanced. Sometimes it would occur in the evening when no trace of it had been seen during the day. A day of alternate showers and sunshine seemed to be most favorable to its production. Remembering that the walls of the chamber were to a considerable degree impervious to heat, so that the temperature within suffered no rapid changes as did that without, these facts suggested the direction in which to seek for the cause of the action. By inserting a thermometer into the chamber and placing another outside, the difference of temperature between the interior of the instrument and the air outside could be measured and its relation to the motion of the needle could be studied. A multitude of observations followed. In every case when the repulsion occurred the temperature of the interior of the chamber was found to be higher than that of the external air. With a difference of a single degree (F.) the needle would be repelled by the gentle heat of the hand held at a distance of twelve inches, while by a somewhat stronger heat the motion would be reversed. With a larger difference of temperature the repulsion would respond to a greater heat, becoming attraction again, however, if a certain limit of intensity was passed. Such observations finally revealed the necessary conditions. Repulsion in air occurs when: 1st. The temperature of the interior of the instrument has been for some time a little higher than that of the external air; and 2d. The degree of heat applied is appropriate to this difference of temperature.

The next step was to carefully determine the place of the zero of the needle scale. Call to mind the arrangement. The slender needle is suspended horizontally by two parallel silk fibres. The torsion of these fibres is a delicate force tending to hold the needle in a certain position. The place of the disk thus held at rest is the zero of the scale. Now the swinging of the needle toward the zero can indicate no positive action of any force other than the torsion of the fibres. Its swinging away from zero, however, can be due to nothing less than some positive force which overcomes the torsion. Having determined the place of the zero, repeated observation showed that the repulsion was real, since the needle moved beyond its zero in opposition to the torsion of its fibres.

In explanation of this curious effect I offer the following suggestions. It is well known that a cooled surface will cause a downward air-current in contact with it, and again that heat being applied will reverse the direction of this current. But this reversal can not be affected instantaneously. The effect of a *gentle* heat will be first, to *slowly* neutralize the cold and thus *gradually* diminish the downward current, and second, afterward to produce, as gradually, a current upward. Now while the cold current is being neutralized, the torsion of the fibres will carry the disk to its zero and when the upward current is established the disk will be again wafted toward the warmed surface. But if this transition from a downward to an upward current is very slow there must be an appreciable time when there is equilibrium, when the air is in contact with a surface warmer than itself and yet for a brief period is free from convection currents.

Again it is well known that the air is perfectly elastic and further that an elastic body will transmit the energy of blows which do not put its mass in motion. Then let us conceive a mass of air, lying between the disk and the surface which receives the heat, subjected on the surface side to a temperature higher than its own and yet free from convection currents. Under these conditions the elastic medium must transmit the heat energy to the disk in a manner not altogether unlike the transmission of the force of a blow by a series of elastic balls. As I conceive the molecular motion it is this. The molecules of air are in motion with a velocity depending upon temperature. When they impinge against the warmed surface they are thrown off with an increased velocity. This velocity is transmitted until the molecules in contact with the disk receive it and they strike the disk with greater energy than do those against the opposite side. This excess of energy drives the disk along.

If this explanation is correct then while the attraction in air is the manifestation of the well-known convection currents, this repulsion in air is the manifestation of *a molecular transmission of energy* by the air in straight lines outward from a heated surface. Now if such a molecular action do exist, then a light body near a heated surface must, in every case, be subject to the influence of these antagonistic forces, being solicited toward the heat by convection, and repelled from it by the energy transmitted. Because convection is the more powerful, the motion is toward the source of radiation, except when by careful choice of conditions the delicate repulsion can be made visible.

Whether this repulsion in air is at all related to the repulsion in vacuo, I am not prepared to consider clear. The effect of exhaustion, on the relative strength of these two forces, is, however, an interesting point in this connection. In a good vacuum the power of convection must be vastly reduced and as the vacuum approaches perfection, this power must approach annihilation. On the other hand nothing short of an absolute vacuum can forbid the molecular transmission of energy. It seems highly probable that at a certain high degree of exhaustion this molecular energy would be the more powerful of the two, and hence that repulsion would be the normal instead of the exceptional indication of the instrument.

[American Chemist.]

IODINE AND BROMINE IN FRESH-WATER PLANTS.

By H. ZENGER, Munich, Bavaria.

As early as 1862 Mr. Petter examined the ashes of *Cladophora glomerata* for iodine, and on heating in a closed tube the palladic iodide, which he had obtained by precipitating the solution of the ashes of the plant with palladious nitrate, he detected the violet vapor of the liberated iodine. Although only a very small quantity of the plant could be obtained, from a reservoir in the garden of Prof. G. C. Wittstein, he was, nevertheless, quite able to complete a qualitative analysis of the ashes, and to prove the presence of iodine.

My own efforts were chiefly directed, *first*, toward the quantitative determination of the bromine, whose presence, though not yet detected in fresh-water plants, was suspected by me as a companion of the iodine; *secondly*, to try some methods of precipitation for the iodine other than the palladium solution; and *thirdly*, to examine various fresh-water plants not yet investigated, and to obtain the iodine and bromine from them in a pure state, even if in very small quantities.

How varying the composition of one and the same plant may be, according to its location, can be seen from the analysis of Mr. Jessler and my own. He obtained the plants out of pure spring-water; I, out of very hard water. It would be impossible to detect iodine in this water, no matter how concentrated, *but the plants have the property of absorbing the iodine and bromine, and thus concentrating and storing them up.*

I think that, after my experience with Cladophora and other water-plants, I am justified in believing that iodine and bromine occur in water-plants to an extent as yet hardly dreamed of, and that also in land-plants these bodies can be recognized with certainty.

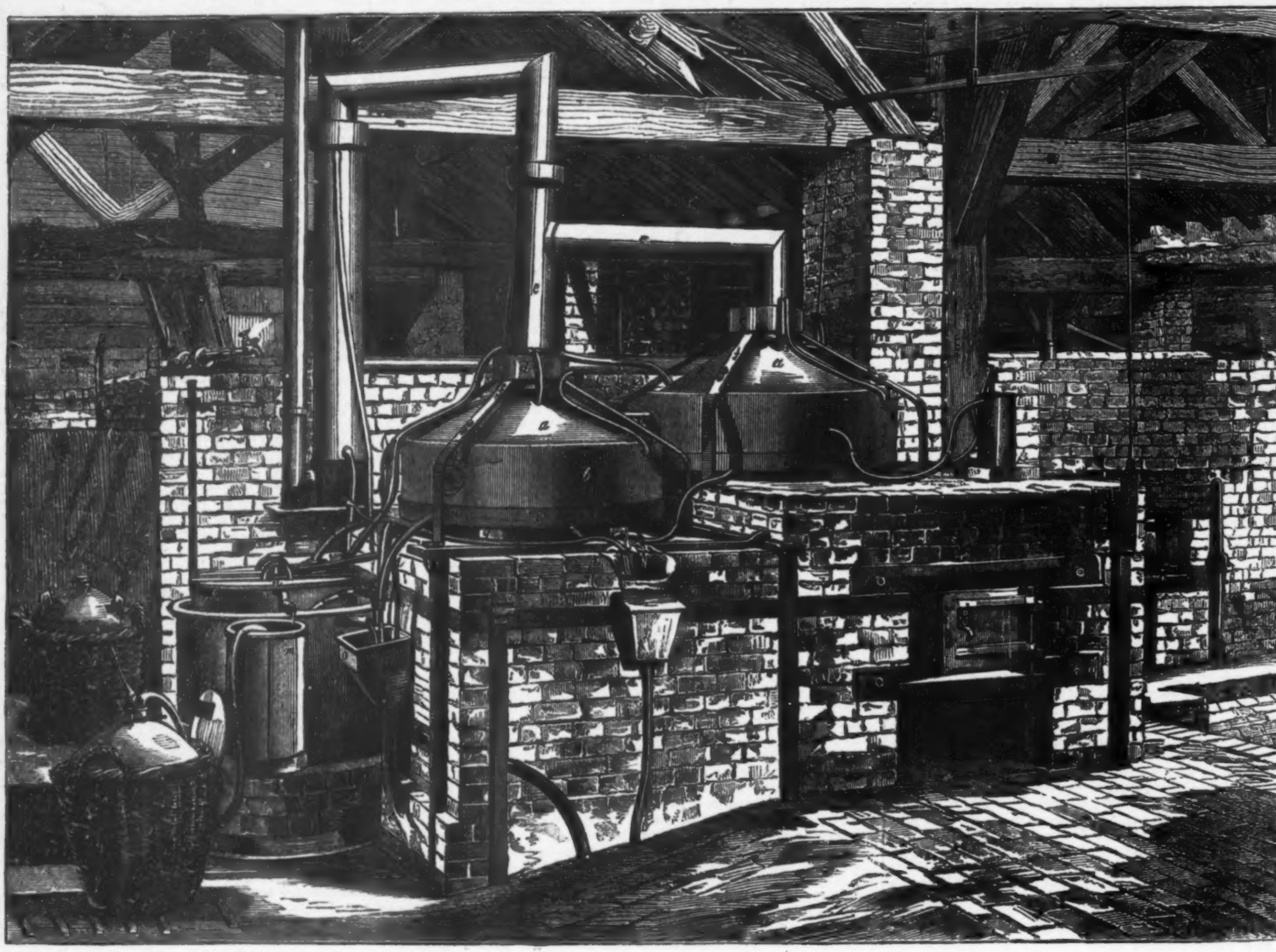
Karl Sprengel, whose worth has been wrongly undervalued, to whom, with better right than to Liebig, we should ascribe the foundation of the new scientific agriculture (for Liebig only built upon the foundation laid by Sprengel, and more than ignored him whose too great modesty and lack of self-conceit—faults no one ever accused Liebig of—were his only mistakes), says: "Very probably iodine is contained in all earths which are rich in sodic chloride. I have found it in small quantities in the subsoil of the marshes on the coast of the North Sea. *Whether or not the iodine belongs to the nourishing materials absorbed by the plant, which is probable, it is at any rate present*, and we will therefore," etc.

That the manganese was present as manganous oxide in the ashes is proved by the evolution of chlorine on treating the ash with hydrochloric acid.

Alumina, almost completely ignored by Liebig, I found in every analysis of the ash. The same result has been very often obtained in Wittstein's laboratory, and by scientists such as Sprengel, Boussingault, and others, who have done so much for agriculture. All these have found alumina constantly present, and often in comparatively large quantities, in the ashes of plants, and hence we are obliged to set it down among the prominent constituents of plants.

On account of the great number of fresh-water plants existing everywhere, it is quite possible that the manufacture of iodine from them may grow to be a branch of chemical industry. I shall direct my attention to the examination, for bromine and iodine, of as many land and water-plants as possible. At present I am engaged upon another water plant, *Lemna minor*. This plant surpasses *Cladophora glomerata* in the large amount of salts soluble in water it contains. Iodine, in considerable quantity, and bromine are present. The exact quantitative results will be given later. Nevertheless we can already say with certainty that iodine and bromine occur much more extensively in the vegetable kingdom than has hitherto been supposed.

ACCORDING to R. Wagner, resorcin mixed with solution of sulphate of copper, and enough ammonia to redissolve the precipitate which is at first produced, yields a deep black liquid which dyes wool and silk, and which may possibly be used as black ink.



APPARATUS FOR THE CONCENTRATION OF SULPHURIC ACID.

[Engineering.]

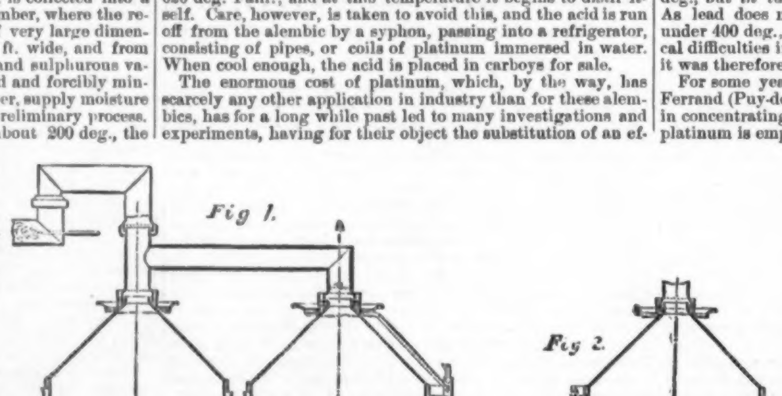
THE CONCENTRATION OF SULPHURIC ACID.

THE sulphuric acid of commerce ($H^2 S O^4$) is a clear, colorless liquid with a specific gravity of 1.845. The common method of manufacturing it is as follows: Sulphur is burnt slowly on the sole of a furnace composed of iron plates. Any desired number of these furnaces may be grouped together, and upon the sulphur are placed at intervals iron pots containing a mixture of nitrate of soda and sulphuric acid, and from which, as combustion proceeds, nitric acid is evolved. This, mingled with the vapors rising from the sulphur, is collected into a large conduit and passes into a leaden chamber, where the reaction takes place. These chambers are of very large dimensions, from 100 ft. to 200 ft. in length, 30 ft. wide, and from 10 ft. to 15 ft. high. The mingled nitric and sulphurous vapors on entering the chamber are agitated and forcibly mingled by the aid of steam jets, which, moreover, supply moisture necessary for the rapid completion of the preliminary process. Thus mingled, and at a temperature of about 200 deg., the nitric acid converts a portion of the sulphurous into dilute sulphuric acid, and is itself converted into nitrous oxide, which, mixing with the air in the chamber, is again changed into nitrous peroxide, which reacts upon another portion of the sulphurous acid, forming sulphuric acid and nitrous oxide, and this process goes on continually repeating itself, the dilute acid falling upon the floor of the chamber with a density of about 1.35.

It may be convenient here to remark that there are three scales by which the density of sulphuric acid is reckoned. The first is simply that of specific gravity. The second mode is according to the Beaumé scale, which is regulated by a hydrometer, so constructed that when immersed in water at a temperature of 53 deg. Fahr., it sinks nearly to the top of the instrument and marks the zero on the scale. It is then immersed in a solution of 15 parts of salt and 85 parts of water, the density of which is about 1.116, and the point to which it rises is marked 15. The space between this latter and the zero is equally divided, and similar divisions are extended on the instrument, as far at least as 66, which is the maximum for sulphuric acid, and corresponds to about 1.845 specific gravity. The third scale of measurement is by Twaddell's hydrometer, in which the scale is not equally graduated, but the divisions correspond to equal differences according to specific gravities. From the chambers the weak sulphuric acid is run off in open gutters to leaden pans, where a preliminary concentration takes place, and the density is raised from 1.35 to 1.70 (60 Beaumé). But to bring the acid to the commercial density of 1.845 it is necessary to abandon the use of lead, which begins to be attacked by the boiling acid at about 60 or 62 Beaumé, and resort to the use of platinum, which remains untouched by it. The alembics employed for this purpose are very costly, ranging in price from 1800*l*. to 3000*l*., and although the acid does not attack the metal, a constant waste goes on, which represents a considerable loss. Moreover, the first cost of establishment is very large. These alembics are placed over suitable furnaces, and heat is applied until nearly all the remaining water is driven off in the form of acid-laden vapors, which are led back to the chamber, condensed, and ultimately brought back to the alembics for concentration. When the acid has reached the density of 1.845, its boiling-point rises to 620 deg. Fahr., and at this temperature it begins to distil itself. Care, however, is taken to avoid this, and the acid is run off from the alembic by a syphon, passing into a refrigerator, consisting of pipes, or coils of platinum immersed in water. When cool enough, the acid is placed in carboys for sale.

The enormous cost of platinum, which, by the way, has scarcely any other application in industry than for these alembics, has for a long while past led to many investigations and experiments, having for their object the substitution of an efficient and much cheaper metal. It is true that glass retorts have been very largely employed for concentrating purposes, but the material is too uncertain and too liable to break to render it suitable. Lead is indeed the most promising substitute, and but for the fact that it is attacked by the heated acid at high densities, no difficulty would be met with in its use. Many experiments—some of them on an extensive scale—have been made with leaden concentrating-vessels. One of the most promising methods was the concentration of the acid *in vacuo*. Concentrated sulphuric acid, as has already been stated, boils under atmospheric pressure at a temperature of 620 deg., but *in vacuo* this temperature falls to about 380 deg. As lead does not appear to be attacked at a temperature under 400 deg., the metal would remain uninjured. Practical difficulties in working this process were encountered, and it was therefore quickly abandoned.

For some years past MM. Faure and Kessler, of Clermont-Ferrand (Puy-de-Dôme), France, have carried on experiments in concentrating sulphuric acid, in which a certain amount of platinum is employed, but the quantity is reduced to a minimum, the form adopted being that of shallow circular pans inclosed in leaden chambers. In the earlier forms of this apparatus rectangular chambers were employed, but this arrangement was found to have disadvantages, and another system was adopted. The sections show that two shallow circular basins are employed; the bottom of these being placed over corresponding openings in the furnace, and they rest upon iron rings laid on the top of the brickwork, the pans having a set-off all round to take a bearing. Each of these basins is entirely inclosed within a leaden bell or dome of the form shown (in later arrangements this was somewhat modified, as we shall see further on). A concentrating arrangement with two basins is shown in the sections. The basins are 28 in. in diameter and 7 in. in depth, and the upper edge of each is turned over so as to form a lip. Underneath this lip is a leaden ring or flange which forms a contact with the platinum, and is the inner boundary of a shallow circular dish with tapering sides. The upper part of this dish is formed with two concentric vertical flanges, which inclose an annular space between them, and this being filled with water, forms the hydraulic joint which seals the bottom of the bell. The leaden dish is supported by an iron ring, carried by a number of adjustable supports, and a second ring is by preference introduced underneath the lowest part of the dish, in order to stiffen it, this ring being held in place by wedges resting on the brickwork of the furnace. Or the ring may be dispensed with, as its only function is to stiffen the lead, which has practically no weight to carry. The bells are 39½ in. in diameter outside, and are formed with annular water-spaces divided into three tiers. Between each tier an iron band is placed around



CONCENTRATION OF SULPHURIC ACID.

the bell, stiffening it, and affording the means of attachment to the vertical standards carrying the whole weight. The total height of the cylindrical portion is 53¼ in., and the bell is completed by a coned top, terminating in a short tubular opening. Around the top of the cone is an hydraulic joint, in which rests the lower part of the tubing, which carries off the heat of the vapors rising from the basins to the chambers. By means of a steam-jet placed in one of these pipes, an induced current of air passes under the lip of the platinum basin, and promotes the exit of the vapors from the bell. A stream of water is kept constantly running over the top of the bell, and falls into the upper annular space around it; thence it falls into the second and afterwards into the third, from which it escapes. By means of this constant circulation, the sides of the bell are kept cool, and the vapors from the basins are freely condensed, and fall down into the lowest part of the leaden dish around the basin. An over-flow pipe is provided for the escape of the dilute acid thus produced, so that it is never allowed to rise beyond a height sufficient to make an hydraulic joint, through which, however, the air can pass, induced by the jet of steam. The basins are placed at different levels, one being about 4¾ in. lower than the other, and a platinum pipe connects the first basin with the open lead-concentrating pans, a second pipe of platinum forms a communication between the two basins, and a third one provides an exit for the concentrated acid. The process is therefore a continuous one, as the acid flows into one basin with a density of 60 deg., and passes from the other at 66 deg. But the amount of work performed by the two basins is not equal, as the evaporation proceeds quite freely in the first one, and the condensed vapors form waters of very low specific gravity. But as the acid rises towards its final strength, it yields its remaining constituent parts of water with difficulty, requiring greatly increased heat to effect this object. The density of the dilute acid escaping from the second concentration ranges from 35 deg. to 40 deg., and the amount of coal required to fully concentrate one ton of acid is 5 cwt. By this continuous process of Messrs. Faure and Kessler 6 tons of acid at 66 deg. can be produced in twenty-four hours, and the work can be carried on as efficiently, though not so economically, in one basin as in two.

On the opposite page we publish a perspective view of a somewhat modified arrangement of the plant, this modification representing the latest improvements introduced by MM. Faure and Kessler. In this illustration *b* represents the cylindrical portion of the bell, which is only about 16 in. in height, *a* is the coned top, *c* and *d* the hydraulic joints at bottom and top of bells respectively, and *e* are the pipes carrying off the uncondensed vapors. The various pipes supplying the condensing-water and carrying it off, the discharge-pipe for the dilute acid, and that leading the concentrated acid from the basins to the refrigerator, are all clearly indicated. This refrigerator is shown at *n*, and from it the cooled acid runs into the reservoir *m*, whence it is syphoned into the carboys. The apparatus illustrated has two platinum basins 29½ in. in diameter, and is able to produce 7 tons of acid per day.

The refrigerator referred to is also designed by Messrs. Faure and Kessler, and is made of lead, instead of being for the most part of platinum. In its most improved form it consists of a leaden vessel, divided about half way of its depth by a horizontal leaden partition. Below this is placed an annular leaden chamber, the space around this chamber being kept full of water. Above the partition is a coil of flat leaden tubes through which water also circulates. In the middle of this coil is a vertical platinum tube, an extension of that leading from the second basin. The hot acid runs through this tube, and falls into a porcelain cup resting on the lead partition before spoken of. Here it is partly cooled, and overflowing the cup comes into contact with the lead, the temperature of which is kept down by the circulating water. As the acid rises in the upper part of the leaden chamber, it overflows into the annular space in the lower part, and is finally cooled. This arrangement appears to work with tolerable success, although it would seem difficult to prevent the acid from being clouded by sulphate of lead, created from the contact of the heated acid with the lead, and without an ample supply of cooling water it would evidently become quickly destroyed.

But as regards the efficiency of the concentrating apparatus there can be no doubt, as it has been so largely tried on the Continent, and in England it is now working with marked success at Messrs. Muspratt's chemical factory, Liverpool. As to the importance of substituting a cheap material like lead for so costly a metal as platinum, there can be no doubt, and MM. Faure and Kessler, in their apparatus, appear to have entirely removed all the objections to the use of lead which have hitherto prevented its employment. We may mention that these manufactures are represented in England by Mr. A. Savée, of 22 Parliament street, London.

NEW EBULLIOSCOPE.

By P. M. E. Malligand, Paris, France.

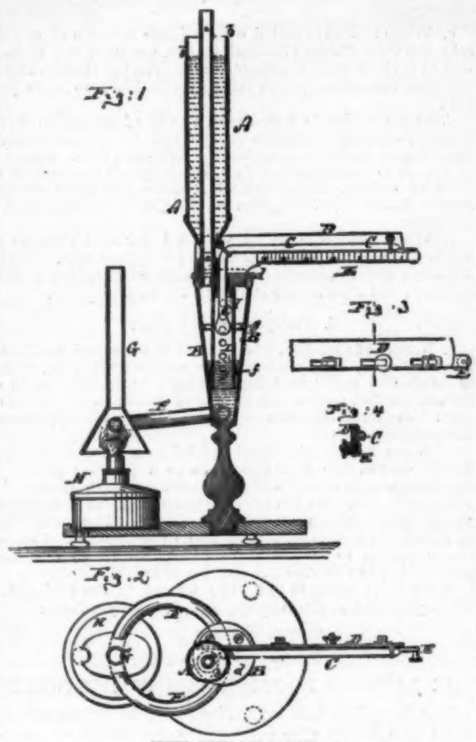
An instrument for ascertaining the proportion of alcohol present in liquids.

It was found by the Abbé Brossard-Vidal that alcohol holding certain matters in solution, such as sugar, resins, citric and tartaric acids, gives a different result, the presence of these matters in moderate quantities not affecting the boiling-point of the alcohol in which they are dissolved. This fact led to the method of estimating the proportion of alcohol present in wines and other alcoholic liquors by comparison of their boiling-points with the boiling-points of different mixtures of alcohol and water in known proportions.

Fig. 1, a vertical central section. Fig. 2, top view. Fig. 3, a detail back view of the bar which supports the thermometer and the sliding scale. Fig. 4, a vertical cross-section thereof.

These improvements consist, first, in the application of a condenser or cooler, A, to condense the vapors of the liquid undergoing the test and return the condensed liquid to the boiler B, and so maintain the composition of the said liquid constant during the whole time occupied in testing it, which may be five minutes or more, thus enabling the alcoholic strength of the boiling liquid to be determined with perfect certainty. Among the various arrangements which might be devised for attaining the desired result, it is preferred to use for such condenser two straight tubes, *a* and *b*, of glass or metal, placed concentrically, the one *a* within the other *b*, and screwed or otherwise fastened into the unclosed opening of the cover *d* of the boiler, or otherwise attached to the boiler. At the bottom of the cooler may be fitted an exhaust-cock. The thermometer, C, of the instrument marks 100° centigrade (212° Fahrenheit) or 86° (187° Fahrenheit) toward the extremity of its stem, and 86° (187° Fahrenheit) or 76° (169° Fahrenheit) at about four fifths of an inch from the bend of the stem, according as the thermometer is made to indicate the whole of the alcoholometric scale from 0° to 100° (32° to 212° Fahrenheit), or a part only from 0° to 25° (32° to 77° Fahrenheit); but the alcoholometric degrees may be further subdivided into as many parts as may be necessary. The thermometers may, moreover, be provided with small reservoirs or chambers to contain a certain number of degrees, according to the requirements of the graduation.

Another important feature of the invention consists in causing a circulation in the ebullioscope of the liquid by heating it in detail instead of applying heat directly to the whole bulk of the liquid.



NFW EBULLIOSCOPE.

On the temperature of the small quantity of the liquid contained in that portion of the tube F exposed to the flame being raised, a circulating movement will ensue, which is soon imparted to the entire bulk of liquid, whose boiling-point thus becomes so constant that it may be maintained for about ten minutes. A small fixed or movable deflector, *i*, or perforated tube, is also provided, and suspended from the cover *d* into the boiler, its upper end admitting the bulb of the thermometer. This deflector serves, when plunged into the boiling liquid, to prevent the tumefaction of the alcoholic liquid during ebullition, which it regulates constantly, and to direct continually the hottest liquid to the centre of the boiler—that is to say, toward the thermometer-bulb—while allowing the bubbles of steam to ascend at the same time that the slightly-cooler liquid passes down near the sides of the boiler, and, on reaching the bottom, reascends, and continues then to circulate throughout the whole time of boiling.

The instrument may be used for determining the boiling-points of liquids generally, either alcoholic or not, and whether simple or compound, the thermometer being immersed in the liquid contained in the boiler, or merely in the steam of said liquids.

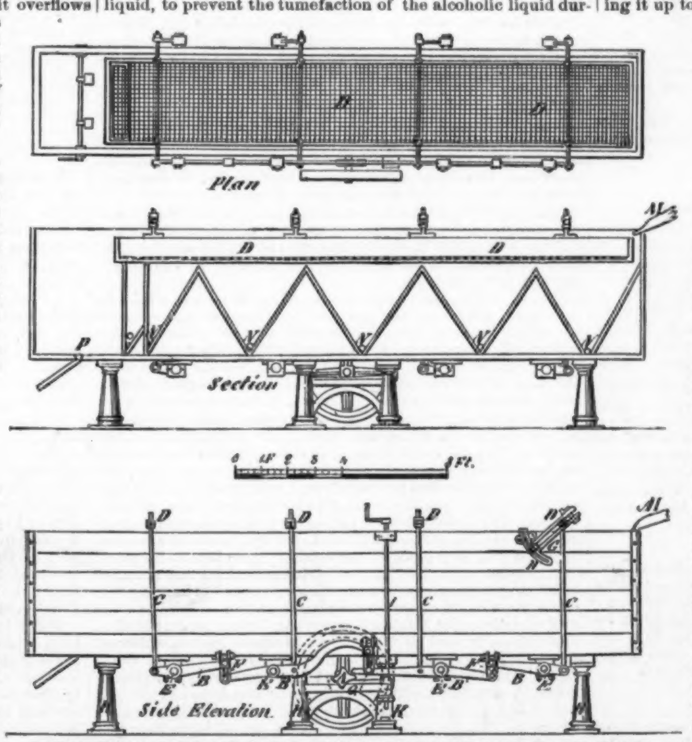
In using the apparatus, pure water is placed in the boiler until it reaches the lower ring *f*, or mark, in the boiler. The water is then boiled, the boiling-point being noted by bringing the zero of the movable scale E opposite the degree indicated by the mercurial column. The water is then replaced by the liquid to be tested, care having been taken to rinse out the boiler with some of the same, so that no water is allowed to remain. The boiler is then filled up to the upper ring *g*, or mark, in the boiler, and cold water supplied to the condenser-vessel *b*, attached at the top of the instrument. The lamp is then lighted, and as soon as the mercurial column becomes stationary in the stem, then, by means of the mercury above the scale E, the degree of the boiling is at once indicated.

EXHIBIT OF THE COPPER-MINING MACHINERY USED AT THE MOONTA MINES, YORKE'S PENINSULA, SOUTH AUSTRALIA.

These mines are said to be the most extensive copper-mines in the world. They have returned in the fourteen years of their working nearly £1,000,000 sterling in dividends, and at present employ about 1500 persons. Some of the lodes are exceedingly good, producing ores that do not require any "dressing" process; other portions of the mines yield vast quantities of "dredgy" vein-stuff, which of necessity has to undergo a considerable amount of dressing to separate the waste from the ore ere it becomes fit for the market, say at from 18 per cent upwards. So poor was the greater quantity of the stone raised from the mine (which is now down in places to the 145 fathom level) that it would have been impossible to have continued working many portions, except at loss, but for the invention of specially-adapted dressing-machinery by Captain H. R. Hancock, the manager of the mines. The chief merits of the invention are that (1) it will deal with a vast quantity of material in a given time; (2) it will bring low-class ores up to a marketable percentage at a minimum of cost (about fivepence per ton); (3) that there is comparatively little wear and tear in use; and (4) that its action is altogether automatic. To describe it in the simplest terms, let the reader imagine to himself a hutch or trough, 24 ft. long, 4 ft. deep, and 4 ft. wide, externally rectangular, internally fitted with false sides sloping towards each other like the letter V, and partitioned with seven compartments, the divisions likewise sloping, whilst an eighth compartment is reserved at the end for receiving the tailings. Into the top of the hutch is placed a sieve 20 ft. long, 3 ft. 3 in. wide, and fitted with sections of wire-work of graduated gauges over the respective partitions. In this way the section nearest the head has six holes to the square inch, the next five, and so on; and they are capable of variation according to the material to be operated upon. In practical working the material is fed to the jigger direct from the crushing-mill with a stream of water, and a motion is imparted which may perhaps be best described as a compound of simultaneous horizontal and vertical movements, by which the stuff operated upon is continuously raised and shaken into another place, the heavier portions—that is to say, the orey parts of the stuff—precipitating through the sieves into the hoppers or compartments underneath, whilst the waste is urged forward by the stream and the pulsations of the machine to the tailings compartment. As the ore separates itself it is permitted to fall through slides (opening at pleasure) into a barrow or train-wagon (as the case may be), to be conveyed to the floors or to the heap of tailings. In the compound motion above described the play of the sieve is about a quarter of an inch vertically and five eighths of an inch horizontally, the total pulsations being about 150 per minute. It should be added that these motions are capable of very minute adjustment, according to the quality of the orey stuff to be operated upon; and that the motion is of itself sufficient to perform the dressing process in *still* water, without the aid of a stream. The machine will deal with from 100 to 150 tons of stuff *per diem*, bringing it up to an average of 19 per cent for copper, about 4 per cent higher than any dressing-machinery previously in use. I understand that the inventor is forwarding a working model of this admirable machine to the Centennial Exhibition.

E. H. Derrington.

Moonta, South Australia.



THE INTERNATIONAL EXHIBITON OF 1876.—HANCOCK'S COPPER ORE JIGGER.

REFERENCE TO ENGRAVING.

A, cam-wheel and drawing-shaft, giving motion to the whole apparatus; B, levers running lengthwise, connected by loops and pins keyed to arbors. The cam-wheel which strikes the end of one of the levers conveys uniform motion to the machine. C, upright rods conveying motion from the levers to the sieve-bars; D, horizontal sieve-bars resting on the upright rods and suspending the sieve. The sieve is also marked D. E, arbors on which the levers are keyed running across underneath the hutch in order to convey the motion uniformly to both sides of the sieve; F, loops connecting the different levers with movable pins; G, oblique rod or lever fixed to the hutch and connected with the sieve, thus giving compound motion to the sieve—namely, up and down combined with forward and backward movements. H, iron (cast), grooved, fastened to the hutch, and to which rod G is fastened with a screw which can be moved so that the obliquity of the angle of rod G can be set at pleasure; I, rod for regulating the extent of the motion, and by which means the machine can be quickly thrown out of gear by screwing the lever high enough to allow the cam-wheel to pass without striking it; K, cast-iron pillars, which can be made any height that may be most desirable for any particular situation on which the machine may be erected; L, fly-wheel, which also serves as belt-driving wheel; M, inlet or feeding launder; N, outlet for dressed ore; O, outlet for ragging or dredge-ragging; P, outlet for tailings; Q, lubricating-box.

LIGHT AND LUNACY.

It appears from the recent experiments of Dr Ponza, in Italy, who has been assisted in his researches by the eminent astronomer Father Secchi, that light acts in a very energetic manner upon brain-affected patients according to the color of the glass through which it falls. In a room lighted by windows of red glass, and painted inside of the same color, was confined a lunatic afflicted with the utmost depression. At the end of three hours he was found to be gay and smiling. In a blue room a lunatic of a most obstreperous nature recovered his calmness within the space of an hour. A third lunatic, after having passed a day in a violet chamber was pronounced so well that he was allowed to leave the asylum. At the present moment he appears to be quite cured.

[American Chemist.]

STATISTICS OF PETROLEUM IN THE UNITED STATES.

Compiled by C. F. CHANDLER, Ph.D.

THE following figures have been selected from the report of the second geological survey of Pennsylvania and the circulars of Tetens & Beling, and Beling, Niemeyer & Wessels, of New York, and of G. R. Babbitt, of Petrolia, Pa.:

PENNSYLVANIA PETROLEUM.

Year.	Production in barrels.	Average price for year at wells.	Total value at wells.	Exported crude or its equivalent, barrels.	Value of exported at wells.
1859	3,200	$13.00	$41,764	....	....
1860	650,000	6.72	4,368,000	....	....
1861	2,113,600	2.73	5,770,128	27,812	$75,926
1862	3,056,606	1.08	1,135,096	272,192	457,232
1863	2,611,359	3.99	10,419,323	706,293	2,818,009
1864	2,116,182	9.66	20,442,318	796,824	7,697,319
1865	2,497,712	6.57	22,979,967	745,136	4,895,556
1866	3,597,527	3.73	13,418,775	1,685,761	6,287,868
1867	3,347,306	3.18	10,644,443	1,676,300	5,330,634
1868	3,715,741	4.15	15,420,325	2,429,498	10,082,416
1869	4,215,010	5.85	24,657,730	2,568,713	15,026,971
1870	5,659,000	3.80	21,504,200	3,530,068	13,414,258
1871	5,795,000	4.35	24,208,250	3,880,326	16,922,918
1872	6,539,103	3.75	24,521,636	4,276,660	16,037,475
1873	9,879,455	1.84	18,178,197	4,981,441	9,165,851
1874	10,910,303	1.17	12,765,054	4,903,970	5,737,644
1875	8,619,629	1.21	10,429,768	5,200,000	6,292,000
Total...	76,336,733	....	$245,904,880	37,690,971	$120,242,147

THE EXPORT FOR 1874 AND 1875.

	1874.	1875.
Crude oil, barrels (42 gallons)......	209,008	386,664
Refined oil " "	3,463,128	3,549,532
Lubricating oil, bbls. "		2,584
Naphtha " "	199,660	283,676
Residuum " "		47,316
Refined oil, cases (10 gallons)......	2,738,595	2,621,507
Naphtha " "	1,550	19,100
Equiv. of above in crude oil, bbls..	4,903,970	5,200,000

As nearly all the oil exported is refined in this country, we may add $2 per barrel for refining, and also, $2.50 per barrel for transportation to the seaboard, when we shall have as the value of the export:

	For 1875.	Total to end of 1875.
Oil at wells................	$3,292,000	$120,242,147
Cost of refining............	10,400,000	75,381,942
Cost of transportation.......	12,500,000	94,227,427
Total..................	$29,192,000	$289,851,516

The wells drilled in Pennsylvania to end of 1868 were 5560, yielding 27,700,000 barrels of oil, the average being 4600 barrels per well; at the average price of $4.06 per barrel, yielding $18,700 per well. Owing to a better understanding of the strata of the oil region, better results have been obtained since. During the years 1869 to 1874, inclusive, 4939 wells were drilled, yielding 42,000,000 barrels of oil, or 8400 barrels per well, which at $2.90 per barrel, the average price, has given $24,500. Of the entire 10,499 wells drilled to the end of 1874 (in oil-producing territory only), 3250 were pumping at the beginning of 1875. The daily yield during the month of November, 1875, was in—

Butler and Armstrong counties..............	15,017	barrels
Clarion district..............................	4,890	"
Upper oil-country............................	3,350	"
Bradford district.............................	195	"
Total..	23,452	barrels

No data are at hand for the yield of the wells in West-Virginia, Ohio, Canada, etc., but the amount is small when compared to the above figures from Pennsylvania.

[Chemical News.]

LABORATORY NOTES.

By SIDNEY LUPTON, M.A.

1. *Preparation of Nitrogen.*

NITROGEN in quantity is generally prepared by leading air over copper-turnings ignited in a glass tube. Oxide of copper is formed, and nitrogen passes over alone—

$$(2N_2 + O) + Cu = CuO + 2N_2.$$

A considerable length of copper must be heated, and the reaction comes to an end when the copper is somewhat thickly coated with oxide.

It was suggested to me by Mr. Vernon Harcourt that if the air was mixed with ammonia by bubbling through a strong aqueous solution, the oxide of copper would be reduced as fast as it was formed, and the reaction would be continuous as long as the solution contained any ammonia. Air and ammonia would give nothing but water and nitrogen—

$$3(2N_2 + O) + 2NH_3 = 3H_2O + 7N_2.$$

On trying the experiment I found that about 3 inches of copper-turnings, heated by an ordinary Bunsen burner, served to replace the long furnace and combustion-tube of the ordinary method, and that the slightest excess of air shows itself by tarnishing the surface of the turnings. Indeed, by this method I have several times prepared nitrogen so pure that a stream of it did not alter the surface of fused potassium.

2. *Solubility of Naphthalen in Water.*

Naphthalen is generally stated—I think on the authority of Garden—to be insoluble in cold water, and but slightly soluble at the boiling-point. It is found, however, that naphthalen, like camphor, moves spontaneously when placed upon the surface of water. According to the theory of Platteau these movements are due to the high surface-tension of a solution of the moving solid. Hence this theory must be laid aside if Garden's statement be absolutely correct.

Naphthalen, purified by re-sublimation through filter-paper, was boiled for some time with distilled water: the solution was allowed to cool to the temperature of the room, and filtered twice through Swedish filtering paper. A portion of the solution was evaporated to dryness on the water-bath; no residue was left, since naphthalen is very volatile in steam, and this may have occasioned Garden's statement. Another portion of the solution was heated in a glass bulb, and the boiling-point taken by a thermometer immersed in the liquid: it was 103° C.; a small piece of clean platinum wire occasioned no change. The boiling-point of freshly-boiled distilled water was then taken under exactly the same conditions; it was found to be 10.24° C., and after throwing in the clean platinum wire 102.1° C.

On another occasion the solution was made from ordinary filtered water; the boiling-point, with or without the platinum wire, was found to be 103.2° C., that of the water itself being 101.4° C., or with the platinum wire 101·3° C.

From these experiments it seems that sufficient naphthalen remains in solution to alter the boiling-point at least half a degree, and that Garden's statement cannot be taken as being absolutely correct: hence no doubt is thrown on Platteau's theory. It may be remembered that camphor itself is but very slightly soluble in water.

3. *Tests for Aniline.*

α. When aniline is boiled with a dilute solution of chloric acid, the color changes through mauve, magenta, and vermillion to a clear reddish yellow liquid. Naphthylamin, under the same conditions, passes through blue-black to light yellow.

β. When aniline is boiled with excess of potassium ferricyanide, the yellow solution changes to a deep chrome-green. After longer heating a blue-black precipitate falls, apparently similar to that obtained by Letheby by the electrolysis of salts of aniline. Naphthylamin, under the same circumstances forms a yellow-green solution, with separation of a red resin.

γ. When aniline is heated with a 1 per cent solution of osmic acid a thick, black, flocculent precipitate falls. Naphthylamin under the same circumstances forms first a purple solution, and after longer heating a brown precipitate.

4. *Tests for Succinic Acid.*

α. Nitrate of uranium, when added to a neutral succinate, forms a very sparingly soluble pale yellow precipitate, which is soluble in acetic acid, but insoluble in solution of oil of amber, alcohol, excess of succinate of ammonia, or acetate of soda. Uranium benzoate is almost identical in appearance and properties.

β. When nitrate of cobalt is added to a solution of a *neutral* succinate, the liquid changes to a peculiar purple or "peach-blossom color," and if the solution be concentrated a precipitate falls. On the addition of ammonia the solution so precipitated becomes more and more blue. This precipitate is soluble in acetate of soda. The presence of oil of amber seems greatly to facilitate the precipitation; as also does alcohol, but in this case the precipitate is pink.

Benzoate of cobalt is red when formed in the cold, green when produced at the boiling-point; it is very soluble.

[British Journal of Photography.]

THE LARGEST PHOTOGRAPHS IN THE WORLD.

THE Australian mail brings, *inter alia*, the Sydney *Evening News* of a recent date, from which we extract an article under the above heading, that speaks highly for the skill and enterprise displayed by our antipodean brethren.

Mr. B. O. Holtermann, the well-known gold-miner, and one of the richest men in the colony, claims to have produced the largest photographic views in the world. This is, of course, saying a great deal. Our Yankee friends, who are proverbial for big things, may possibly be inclined to dispute Australia's claims to photographic superiority; and one can even fancy he sees a smile of incredulity lighting up the face of Brother Jonathan when such an announcement as the above reaches his ears. But let us see how far Mr. Holtermann's claim is justified by facts.

After having made his fortune at gold-mining Mr. Holtermann, at the instance of the late Mr. Beaufoy Merlin, whom he engaged as a private photographer, started to take photographic views of the principal parts of New South-Wales and Victoria, with the idea of one day making a tour of Europe, and exhibiting a grand panorama of the Australian colonies especially New South-Wales, as a field for emigration. The idea is a philanthropic as well as a patriotic one, and does credit to the heart and head of the lucky digger. To carry out the idea succesfully, however, Mr. Holtermann came to the conclusion that no half measures would do. It must, he argued, be done on a grand scale, or not at all; and with the fixed determination of making his show the largest and most complete in the world he set about his work in real earnest, and spared neither time nor expense in the fulfillment of his grand idea.

Having a keen appreciation for the beautiful in nature, he fixed on the magnificent harbor and scenery of Port Jackson as the centre of his labors. He purchased a site of land at the North Shore (Blue's Point, the highest point in the locality), from whence he could command an uninterrupted view of the city and harbor of Sydney. Here he built at enormous cost a residence fit for a nobleman, and one which, though its approaches and surroundings are not yet in a finished state, is an architectural ornament to the locality in which it is situated. On the summit of the building is a tower ninety feet high, from whence the views are taken; and perhaps from no other spot in the colony can such a magnificent view be obtained as from this elevation. For miles around the eye rests upon one splendid panorama of natural and artificial scenery, not to be exceeded for beauty by any place in the world. Here was an immense advantage possessed by Mr. Holtermann, and he was not slow in turning it to good account. The most perfect instruments that money could obtain were placed at the disposal of his staff of artists (for Mr. Holtermann employs a regular staff of photographers, and is himself an amateur photographer of considerable experience). Unfortunately the sudden death of Mr. Beaufoy Merlin interfered for a time with Mr. Holtermann's plans, but an efficient successor was found in the person of Mr. C. Bayliss, under whose direction the great views of which Mr. Holtermann is now so proud have been produced.

He has two views of Sydney and harbor, each five feet by three feet two inches, and two of four feet six inches by three feet two inches. These photographs, Mr. Holtermann claims, are the largest ever produced from single negatives. They give a complete view of the city and harbor of Sydney from Garden Island to Long Nose. No. 1 negative, which is five feet by three feet two inches, takes in the space from Garden Island to Dawes' Point; the second, of the same size, embraces from Dawes' Point to Miller's Point; the two others, each four feet six inches, showing from Miller's Point to Long Nose. Apart from the size of the pictures, they are splendid specimens of the photographer's art, the outlines being sharp and clear and the various objects shown coming out prominently before the eye. The difficulty of producing pictures of such size can be best understood and appreciated by photographers, among many of whom, we understand, it is believed that it is not possible to execute photographs of such magnitude. If such a belief exists, Mr. Holtermann claims to have dispelled it, and to have worked a revolution in the art of photography.

In addition to these, Mr. Holtermann has had executed a panoramic view of Sydney and the harbor, thirty-three feet in length. This embraces a distance of about six miles in length, and the whole of the perspective is shown much clearer than can be seen by the naked eye. Signboards between two and three miles off can be seen easily without the aid of a glass. Messrs. Goodlet and Smith's Victoria Saw and Joinery Mill's signboard can be read on both picture and negative without any difficulty, while the comparatively small sign "Moore's Book Mart," in George Street, near the Town Hall, could be distinctly seen with the naked eye. There is but one defect in the picture, and that is one that can not well be avoided—namely, the obscure and slightly "smudged" look of the shipping in the harbor. The motion of the craft upon the water renders this defect unavoidable.

These views are the principal ones; but Mr. Holtermann's studio is stocked with thousands of photographic views, all splendid works of art, of different parts of New South Wales and Victoria. It is his intention to start for England early next year with his grand panorama of Australia, his principal object being to induce emigrants to come to Australia; and, as the expense he has already incurred is something enormous, Mr. Holtermann considers that government aid should be given to a project designed solely to advance the interest of the colony.

[Moniteur de la Photographie.]

HOW TO PRODUCE PELLICLE CLICHES, AND TO OBTAIN A PORTRAIT AND FRAMEWORK AT ONE PRINTING.

By C. QUESNAY.

Two clichés are necessary to obtain prints of this kind, one upon pelicle, the other upon glass, and it is by the superposition of the two clichés that the portrait and framework are obtained together.

First Cliché.—Take an ordinary glass plate, rub it well, and apply a solution of—

Ether at 65°	. . . .	500 cub. cents.
Virgin wax	. . . .	.05 " "

The solution should be filtered, before application, through a tuft of cotton-wool. Evaporation takes place very rapidly, but in winter-time a little warmth is desirable. The surface having dried, it is rubbed gently by means of a dry tuft of cotton-wool, moisture having the effect of removing the film of wax altogether. The plate is in this manner rendered transparent, and several may be prepared in like manner ready for use.

The plates are next coated with collodion, and sensitized ready for use. Before producing your negative, however, you trace upon the ground glass of the camera, and focus carefully, so that the portrait falls in the middle of this oval. Between the partition of your dark slide and the sensitized plate you next place an oval cut very cleanly, which corresponds precisely to that upon the ground glass. In this way you obtain the ground around the portrait of a transparent nature, which is indispensable in the production of such photographs as I am describing.

The portrait taken and the cliché produced, it is not varnished, but put upon a levelling stand, and there is poured over it a fifteen per cent solution of gelatine, care being taken to prevent air-bubbles. The film, about a millimetre in thickness, is allowed to set, and it is dried in a position sheltered from the dust. When perfectly dry, a little mattolein is rubbed over it, to facilitate any retouching that may be necessary.

Afterwards some normal collodion is poured on, made up of—

Ether at 65°	. . . .	50 cub. cents.
Alcohol	. . . .	60 " "
Pyroxyline	. . . .	2 grammes
Castor oil	. . . .	2 to 3 drops

It is always necessary that the alcohol should be in excess so that the film of wax is not dissolved away by the collodion.

Four strips of paper are attached, preserving the margin so that your portrait may be easily shaped, and when the whole is dry, four cuts with a penknife suffice to detach it from the glass.

Second Cliché.—Put upon the object which you desire shall form the framework of your portrait a black oval block of the size of the portrait upon the first cliché. Then take a negative in the ordinary way, which will have its center transparent. This cliché is varnished and placed upon the pellicle negative, attaching the latter by means of a little gum, and then you print as if you had to do with a single cliché only.

If you wish to give your portrait two separate tints, you must proceed as follows:

Wash your prints well as soon as they come out of the printing-frame, to remove every superfluous trace of nitrate of silver, and then place the pictures in sheets of filter-paper specially employed for the purpose. Dip a brush into a solution of hyposulphite of soda (20 per cent strength), and draw it over the portrait-following the outlines thereof. Every part of the portrait being thus treated, wash thoroughly in water, and then tone. You will in this way have secured two tints: the framework of a sepia tone, and the portrait of a violet color.

There is a second method, which consists in taking the portrait without an oval, either in the dark slide or camera. Your negative is made as shown in the case of the first cliché, and upon this is put a sheet of paper, the object of which is to prevent fraying, and then the pellicle is removed upon a sheet of mica, attached by means of gum. The same thing is done in the case of the frame; and you then possess two ovals, one a block and the other an open one.

The means I have described of securing two tints was indicated by M. Haritier in 1865. With a double cliché it is very easy thus to obtain portraits in carbon without transferring; or, in other words, the paper which receives the carbon tissue serves as a definite support, and the print is found to be in its true position, because you have printed through the pellicle cliché.

I think that the method I have indicated will be of the greatest assistance to photographers printing cartes de visite in carbon, for it is very difficult, even with the aid of guiding-points, to make the portrait coincide with its framework. There is nearly always a line of demarcation to be seen, but when one has to do with a double cliché this never happens. If either the framework or portrait prints too fast, the one or the other is covered with a piece of transparent paper.

THE UTILIZATION OF VEGETABLE SILK DOWNS.

It is only very recently that the pappus, or silky down, which is found clothing the seeds of several species of plants, and which hitherto has been suffered to run to waste, has been utilized as a material of some importance in certain industrial applications. So far back as 1835 the Society of Arts received from India two large pieces of cloth manufactured from the down of the silk cotton-tree (*Bombax malabaricum*), or *Simool*, forwarded from Gowhatty in Assam, the place of their manufacture. From the report then made on this cloth, it appears that the fine, short down of the *Bombax* is spun into a large, loose, slightly-twisted cord or roving, and this is made into cloth by interweaving it with a warp and shoot of common thin cotton thread, in the manner of carpeting. It thus composes a loose cloth, incapable probably of being washed without injury, but very elastic, warm, and light. From the shortness of the staple and the elasticity of the fibre, it is not at all probable that it could be worked by the machinery now in use for cotton-spinning, but the combination it exhibits of fineness of fibre with great elasticity will no doubt make it rank high as a non-conductor of heat, and therefore be admirably fitted for making wadding, and also for stuffing muffs and coverlets. When combined with wool it might doubtless form the basis of fabrics of great warmth, lightness, and silky softness.

The various species of *Bombax*, which are remarkable for their gigantic size and their splendid flowers, are also remarkable also on account of their capsules, which on bursting display a flocculent substance often mistaken by travelers for cotton. This material, being more silky than cotton, has hence been distinguished by the name of "silk cotton." In India this vegetable silk down is produced in great abundance; and Mr. Williams, of Jubbulpore, succeeded some years ago in spinning and weaving some of it so as to form a very good coverlet.

In Holland the down of the *Bombax* has been extensively used for economic purposes, and it is now gradually working its way into commerce in England, where private firms and companies are turning their attention to it. The Ciba Down Company, at Stockport, have been employing it as a material for down quilts, ladies quilted petticoats, and for other stuffing purposes, for which its peculiar soft and silky nature renders it especially adaptable. In tropical Africa, where the "cotton-trees" attain such a vast size, this silky down of the *Bombax* is also utilized by people who spend their leisure time in spinning yarn of it with the rude implements they have at their command. In Liberia stockings have been made of it, showing the result of African skill in this kind of manufacture. Regarding the manufacture of this substance by the Dutch, it is said that about five grammes of silk down are obtained from each capsule. By care and attention in carding, the quality of the down for beds is much improved, and it is sold at sixpence per pound. One house alone in Holland imports from the Dutch possessions in the Indian Archipelago from 1000 to 1500 bales annually, having found a considerable sale for it not only in Holland, but likewise in England, France, Belgium, and Germany. The oily seeds, like those of cotton, when separated from the down sell for about 12s. the 100 kilogrammes; the oil extracted from them at forty to forty-five florins per hectolitre; and the oil cake, for cattle, at ten florins per 100 kilogrammes. In Mexico the purple down of *Bombax villosum* is spun into a sort of cloth which is much valued by the inhabitants for the manufacture of garments of delicate texture.

INCREASING THE SPARK OF THE INDUCTION-COIL.

To the Editor of the Scientific American:

Reading over the very interesting article of Prof. Houston in the Scientific American Supplement No. 5 (Jan. 29th, 1876), recalls an experiment in which I put to a practical use the strengthening of the spark of the induction-coil by connecting one of the poles of the secondary wire with a large surface. Although it must be known to many of your readers, I have described it below as it is of interest just now in connection with the question of "etheric force."

Desiring, during the winter of 1874, in a lecture on electricity at St. Francis Xavier's College, New-York, where I was professor of physics at that time, to show the application of the induction-coil to lighting gas, I had connected the wires with a dozen well-insulated burners of the same pattern as are used at Niblo's Garden Theatre. The spark, however, would not pass when all were connected; but if only three or four were connected it passed quite readily between the platinum points and illumined the gas. I had no difficulty in concluding—as the coil was small, giving, at the most, a ¾-inch spark—the spark was too weak. On the following day, however, on repeating the trial, by accident one of the secondary wires leading to the burners came in contact with the iron work of the chandelier, and as the wire was uninsulated, communication was established with the gas-pipe. Immediately the spark, which previously had refused to pass between the platinum points of the burners, was so much strengthened that it lit the twelve burners without difficulty. I then connected one of the secondary wires permanently with the chandelier, and the spark never failed to pass even with less battery power. As you will readily see, this was nothing but another instance of Prof. Houston's discovery of increasing the spark of the induction-coil by connecting with a large surface, and is readily explained in the same way.

It may not be out of place to state in conclusion that both of your valuable journals, the Scientific American and the Supplement, are a real wonder to all the Belgians to whom I have shown them, being far superior to any similar journal on the Continent. SAMUEL H. FRISBEE.

11 Rue des Recollets, Louvain, Belgium.

THE EXPORTS REVIVAL.

[Fall River Correspondence of the *N. Y. Times*.]

The shipments of print cloths to England from this city now approximate some 20,000 pieces per week. It is the intention of the manufacturers here to raise the quantity to 30,000 pieces, which will be about one quarter of the weekly production of the place. In the course of a few weeks, as one mill after another comes into line with the changes in machinery necessary to manufacture the requisite goods, the latter number of pieces will probably be reached. Several of the mills that purpose to place a portion of their spindles on foreign orders are prevented from doing so immediately by the fact that they are running on unexpired home contracts. These will terminate, however, on the 1st of April, so that after that date such mills will be ready to contribute their share of the quantity of goods the Board of Manufacturers have agreed among themselves to send out of the country—namely, 30,000 pieces per week.

The goods are of various widths, ranging from twenty-six to thirty-four inches, and the pieces vary in length as the orders may demand. The figuring of the 30,000 pieces is based upon an average of forty-five yards, the usual length of pieces as manufactured here. The total number of yards, therefore, when the full amount is reached, will aggregate in value, at present prices, nearly sixty thousand dollars. This, it will be seen, is at the rate of $3,000,000 annually—about one third of the average annual exports of cotton fabrics from the whole country previous to 1860. During the year 1860, which was the most prosperous in this respect, the reported exports of cotton goods from the United States were some $11,000,000.

It may be said that this reasoning does not allow for future contingencies, and that the weekly supply may not be kept up. This, of course, is more or less true. The indications, however, carefully observed from all quarters, are that it will be, if, indeed, the supply is not increased. It is certain that the manufacturers of this city have given to the subject of the exportation of a stated quantity of their production careful and judicious forethought. The conditions under which the movement has been started are very favorable. Whether they will remain so, is a question for the future to determine. But the prospect at present is altogether encouraging, letters and despatches from the other side holding out good inducements to make the matter both permanent and profitable.

The revival of the export trade in cottons is by no means confined to Fall River, albeit this city has been largely instrumental in creating it. The attention of the manufacturers here is mainly given to a special fabric, though some of the mills that manufacture shirtings and sheetings are making shipments abroad. Other places in New-England, such as Lowell, Lawrence, Manchester, Lewiston, Biddeford, and the cotton-manufacturing districts of Rhode Island are doing an extensive business in this respect. The export trade in cottons, so many years inactive, starts up afresh with renewed vigor, and that, too, at a period when its influence upon the business of the country can not fail to be highly beneficial. Such exports from the city of New-York alone for the week ended March 7th are stated to have been over $268,000. Of this amount $124,000 in value went to China, $26,000 to London and Liverpool, $14,000 to France. The balance was shipped mainly to Germany, Brazil, the West Indies, Japan, and Africa. It is apparent, therefore, that the market is not limited to any country or any part of the world. The shipments from Boston during the same week were also very large—reported to have been $175,000. One steamer loaded entirely with cotton goods, having refused all other freight. Since January 1st, 1876, 12,000 packages have been exported from New-York, in place of 5500 for the same period in 1875, and of 3500 in the same time in 1874. At this rate, and judging from other data since June 30th, 1875, the exports of domestic cottons for the year ending June 30th, 1876, bid fair to be fully double the amount for the year ending June 30th, 1875. In the latter year they were, as officially reported, 28,817,743 yards, and in total value $4,990,695.

[Shenandoah Herald.]

ANTHRACITE COAL FROM SPRING-WATER.

We have before us now on our table a specimen which is one half anthracite coal and the other half a solidified sediment that four years ago was all soft sediment. For over four years there has been in use in the Indian Ridge Shaft of the Philadelphia and Reading Coal and Iron Company, this district, a wooden pipe, about six inches in diameter, made of inch boards nailed together, which served to cary water from one of the rings in the shaft to a lower level. The rings are boxes around the sides of the shaft which catch the water coming out of the rock, slate, or coal, and are put in to prevent the water from falling down and making a regular shower-bath of the shaft. At the ring in question a large spring in the slate, about thirty feet below the Primrose vein, had been struck, the water from which is apparently as pure as crystal. Some four months since it was found that this wooden pipe had become so clogged with the reddish-brown sediment that is deposited by all mine-water, that the open space in it was not more than two inches in diameter, and not large enough to carry off the water from the ring. Consequently a new pipe was put in, and the old one, nearly closed with the sediment adhering to its sides, was left standing. The water was then turned into the new pipe and cut off from the old one, which is some fifty feet or over in length. On Friday last, after remaining in the shaft without any water passing through it for over four months, the greater part of this old pipe was taken out, and when broken open the wonderful phenomenon presented itself that the sediment was gradually changing, into what appears to be anthracite coal. About a half inch of the inside of the sediment lining the pipe had changed into coal, and the remainder was also gradually changing, the only portions of the sediment remaining quite soft being that part deposited first and next the sides of the pipe. A cross-section of the pipe now shows, commencing at the centre, first a circle of about half an inch in diameter surrounding the two-inch opening remaining in the pipe, then a circle of sediment partly turnd into coal, and then the sediment in its natural state and the sides of the pipe. The surface of sediment which was exposed to the action of the atmosphere has changed first, and the same influences or chemical combinations which had changed its nature were gradually operating on the rest of the sediment. The process of formation is plainly seen in the sediment next that already turned into coal.

Samples of coal taken from the pipe have been tried on the blacksmith fire at the colliery, and it makes an exceedingly hot fire, but being of a softer nature than the natural anthracite, it clinkers badly. Fortunately, there are any quantity of samples of this wonderful formation, and those who are unwilling to believe without themselves seeing and touching can be accommodated. There is no Keely Motor business about this discovery. A section of the pipe about 16 feet long has been standing in the shaft to see what results will follow in the next six months or year. Samples have also been sent to Gen. Pleasants at Pottsville for examination, and we suppose the public will soon have the opinion of gentlemen qualified to judge on this surprising formation; but if anthracite coal will form from sediment deposited by mine-water when exposed to the action of the atmosphere under certain conditions for a period as short as four months, what becomes of all the pet theories of the geologist and mining engineer on the subject? How about the great heat, the millions of years of time and tremendous pressure which, according to the various theories of the heretofore accepted authorities, were necessary to account for our deposits of the finest and best fuel yet found?

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS

Synthesis of Aniline Black.—M. J. J. Coquillion.—To demonstrate that aniline black may be obtained without the intervention of a metal, the author had recourse to the following precautions: The slips of carbon which served as electrodes were exposed for three hours to a current of chlorine in a porcelain tube heated to redness. They were then boiled in nitric acid, again submitted to the action of chlorine, and washed in distilled water, when they might be regarded as pure. These points were 1 decimetre in length. To effect the electrolysis, two platinum wires were coiled round their upper parts, and were connected with the two Bunsen elements made use of in these experiments. As soon as the lower extremities of the carbon points were plunged in the salt of aniline the positive electrode became covered with black, whilst hydrogen escaped from the negative pole. It seems, therefore, beyond doubt, that aniline black may be produced without the action of any metal. This fact being established, it remains to be seen which salts of aniline are capable of yielding aniline black. The hydrochlorate and thus alphate alone seem able to produce the black under practice conditions. The author has previously shown that these two salts, when submitted to electrolysis, yield, after the lapse of twenty-four hours, a paste-like mass surrounding the positive electrode. This mass, when washed and dried, is soluble in concentrated sulphuric acid. It has a blackish violet tint, analogous to a solution of violaniline in the same acid; but if water be added to the dissolved black, a greenish mass is immediately precipitated—a phenomenon which does not occur in case of violaniline. This is an important character which seems to distinguish aniline black. This reaction may be obtained even with a slip of dyed cotton. The greenish flakes, however, resume their original black color if the acid is neutralized with ammonia or potash. Two other salts of aniline, the arseniate and the phosphate, or rather a mixture of phosphates, likewise yield aniline black. With two Bunsen elements, however, the operation is slow and difficult. The solution of these salts is syrupy, and after the lapse of twelve hours there are obtained merely small quantities of a black, which likewise is soluble in concentrated sulphuric acid with a red-violet color, and on adding water deposits greenish flakes. The colors, however, do not appear to be identical with those obtained from the hydrochlorate and the sulphate. These salts are not likely to be used in practice. The black from the nitrate of aniline, and that from the acetate, do not present this reaction, and their molecular constitution is probably different. Thus, from a theoretical point of view, we see that it is possible to form aniline black by direct synthesis, and that the same method may doubtless realize analogous synthesis. From a practical point of view, the results are also not without importance. For the success of the operation the solutions ought to be concentrated. Practical men should therefore add as little water as possible, and keep within the limits which experience will easily indicate. The other laws of electrolysis have also their application. Every cause which tends to separate the molecules assists the reaction; a more elevated temperature will therefore be favorable, but to insure uniformity of shade the temperature must be uniform also. A diminution of pressure will have an analogous effect. The printer must therefore beware of employing, as was formerly done, cast-iron drums, where the gases from the reaction, finding no escape, augment the pressure, and thus hinder the formation of the black.

New Spectroscopic Method for Discovering in Gaseous Mixtures and Liquids the Smallest Quantity of a Gaseous or very Volatile Hydrocarbon.—A. and G. De Negri.—Into a Geissler tube is introduced a small quantity of a gaseous mixture, which ought not to contain oxygen, carbonic oxide, or carbonic acid, exposing it to a barometric pressure not greater than 20 m.m. If in the gas under examination a hydrocarbon is present, on causing it to be traversed by a spark from a Ruhmkorff's coil, a sky-blue light suddenly appears, which, if viewed with the spectroscope, presents the spectrum of carbon, and generally so brilliant as to mask totally the spectra of other gases present, not excepting nitrogen.

Spectrum of Nitrogen, and on those of the Alkaline Metals in Geissler's Tubes.—M. G. Salet.—The author, with reference to the researches of Schuster, published in 1872, proposes to demonstrate that a grooved or fluted spectrum can be produced with nitrogen heated in contact with sodium; that the disappearance of the spectrum of nitrogen is due to the disappearance of the nitrogen itself, which is totally absorbed by sodium under the influence of the electric efluve; and that the spectrum described by Schuster should probably be ascribed to the vapors of the alkaline metal.

Transformations of Cane-sugar in Crude Sugars and in the Sugar-cane.—M. A. Muntz.—The sugar possessed of reducing properties existing in crude sugars and in the cane ordinarily consists of an inactive glucose, with which are often associated variable proportions of normal glucose and of levulose.

THE INFLUENCE OF LIGHT UPON THE CHEMICAL CHANGES GOING ON IN THE ANIMAL ORGANISM.

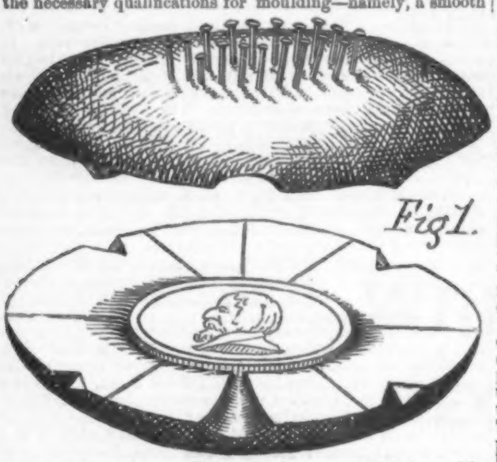
A favorite hypothesis of Pflüger's is that the waking state is maintained, in great measure, if not wholly, by the constant summation of sensory stimuli; and that, by keeping the centrifugal nerves continually in a state of activity, the waking state reacts upon the processes of assimilation and decomposition throughout the body. This hypothesis rests upon a broad basis of circumstantial evidence derived both from physiological and pathological sources. Flaten has performed a series of experiments to ascertain directly whether stimulation of the retina by light really exerts any appreciable influence on the chemical changes going on in the system (*Pflüger's Archiv.*, xi. 4 and 5). Rabbits were made to breathe pure oxygen instead of atmospheric air; the carbonic acid gas given off from their lungs was absorbed by a solution of potash, and quantitatively determined. Light was admitted to, and excluded from, their eyes, during alternate periods of thirty minutes; the proportions of oxygen absorbed, and of carbonic acid given off during the intervals of illumination, being compared with those absorbed and given off during the intervals of darkness. The ratio as regards the oxygen proved to be 116:100; as regards the carbonic acid 114:100; thus confirming the results long ago obtained by Moleschott with frogs—results vitiated by the untrustworthy methods of investigation he employed.

A PROCESS FOR MAKING MOULDS FOR, AND CASTING AND FINISHING ARTICLES IN THE MORE FUSIBLE ALLOYS.

By Geo. M. Hopkins.

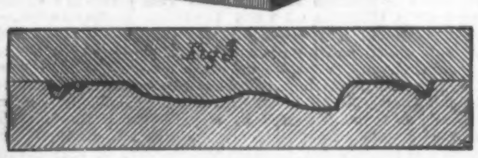
By the following simple process, with few tools and materials, the virtuoso may reproduce his rare and curious articles, the artist may fix his ideas in enduring metals; and the amateur machinist may make smooth, finished castings for various parts of his machinery. It is not supposed that this process will supplant the ordinary means of producing castings for the trades; but it will be found useful and convenient for amateur and artisan.

A medallion, a bass-relief, or an article of less artistic design may be chosen for a pattern. In any case it must have the necessary qualifications for moulding—namely, a smooth



water-proof surface; sufficient *draft* to permit it to be readily removed from the mold; removable pieces for undercut places; core prints, etc. If the article in hand is one which has not all the requisites of a good pattern, a remedy may be found in filling up with wax, or making the mould in several pieces.

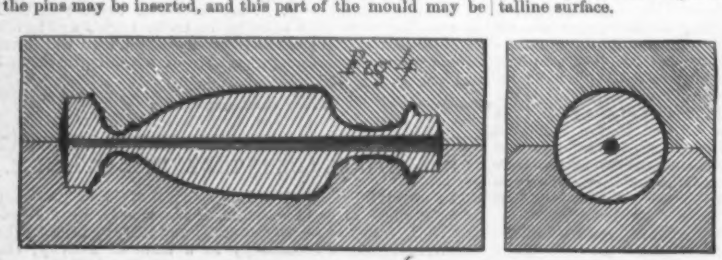
To illustrate the method, a medallion is chosen. If there are doubts about drawing it from the mould, a thin ribbon of wax may be wrapped around its edge. The pattern now receives a coating of oil, the greater portion of which is removed with a pledget of cotton. It is placed flatwise on a piece of glass or smooth board, previously oiled. Two parts of plaster of Paris and one part of powdered pumice-stone are mixed with water to a creamy consistency, and a small quantity of this is poured on the pattern, and washed about with a camel's-hair pencil, until no air-bubbles are seen, then a little more is poured on, so as to overlap the medal about



half its diameter. When the plaster begins to set, common pins are inserted with the points nearly or quite touching the medal. The mould is then built up with the plaster until it is sufficiently strong.

After this part of the mould becomes hard, it must be prepared—while the pattern is still in it—for making the counter part. This is done by first making two slight grooves, which are to locate the channel through which the metal is to be poured; and notching the sides in two or more places.

The part of the mould which will come in contact with the counterpart is brushed over with powdered soapstone, to render it separable. The pattern is oiled and the surplus removed as before. The plaster is prepared and poured carefully over the pattern and upper surface of the mould; care being taken to get it well into the notches, which form the guides for the counterpart. When the plaster begins to set the pins may be inserted, and this part of the mould may be



thickened up until it is stout enough to bear handling. When the plaster becomes hard the pins are removed, leaving vents which facilitate drying the mould and furnish a means for the escape of steam. The mould may now be separated, the pattern removed, and the channel through which the metal is to be poured may be cut in each part of the mould, it being already laid out. Six or eight slight grooves for vents are to be cut radially from the impression left by the pattern to the outside of the mould. The mould must be dried thoroughly in an oven or upon the stove. It is advantageous in some cases to brush the face of the mould over with soapstone-powder, care being taken to not fill the finer lines.

A fine annealed wire is wound about the mould to hold it together. It is then set up in a dish of sand, which holds it upright and obviates any accident which might occur from over-filling the mould.

A bass-relief may be readily copied by taking an impression in precisely the same manner as in the case of the first part of the medallion mould. If the article to be copied is of such a nature that it is inadmissible to copy it in this manner, an impression in wax or gutta-percha must be taken and a duplicate of the article made in Plaster of Paris. After getting the impression from the bass-relief, provision for the thickness of the metal which is to make the copy is made in the following manner:

Paraffine and beeswax, in the proportion of one of the former to three of the latter, are melted together and cast into a thin plate, in a platter which has been moistened to render the wax easily removable. A board having a level surface is prepared, and two strips of wood, having the thickness of the metal in the casting to be made, are placed near opposite edges of the board, as in the illustration (Fig. 2). A roller having an equal diameter throughout, and a length which is a little greater than the width of the board, is provided.

The mixture of paraffine and wax (which will be called *wax*) is warmed slightly (most conveniently in warm-water) and placed upon the board, which must be wet, and the roller, also wet, is rolled over it until it touches the strips of wood, the wax in consequence having been reduced to the thickness of these strips. And now while the wax is still slightly warm—not warm enough, however, to make it adhesive—it is carefully worked with the fingers into every part of the impression of the relief, so that it may have the form of the back of the desired casting. Should the wax stretch so much as to become too thin in some of the deeper places in the mold, it should be backed up with an additional sheet at that point. No attempt should be made to force the wax into the minute depressions, as some of the fine features of the mold might be injured. The wax may be trimmed with a warmed knife, giving the edge of the work the required form. The mold from this point out is proceeded with in the same manner as in the case of the medallion. Fig. 3 is a longitudinal section of a mold showing the position of the wax.

Another example requiring more care, and a different mode of handling, is that of a vase. The one chosen is circular in section, having ornate designs on the exterior. It is proposed to imitate the vase and not attempt to use it as a pattern. The first procedure is to make a wooden mandrel in the lathe having considerable taper, say ⅛ inch to the foot. This mandrel must be made hexagonal in section, and wet to prevent swelling when enveloped with plaster. It is then brushed over with powdered soap-stone, and plaster, prepared as before mentioned, is to be put upon it and roughly shaped into the form of the vase; when this has set, and before it dries, it must be pierced to the mandrel in numerous places with a fine wire. And then allowed to dry.

The mandrel is placed in the lathe and the plaster turned into the exact form of the vase, less the thickness of the metal in which it is to be cast. Cylindrical projections are left on each end of this core to support it in the mould.

Sheets of wax (paraffine and wax equal parts), which are a little thicker than the metal is to be, are worked over the turned core, and fastened at intervals with melted wax. The mandrel is again placed in the lathe and the wax (being cold and hard) is turned to the form and dimensions of the finished work. The ornamentation is made by taking plaster impressions from the ornaments, and pressing thin sheets of wax into the mould thus formed.

The mandrel is now removed and each end of the core capped over with a sheet of wax, which should be somewhat convex.

A small flask might be convenient for further operations; but as the process has thus far been attempted without tools, a paper-box only will be used. It should be two inches wider, and two inches longer than the pattern, and one inch deeper than the semi-diameter of the vase.

A batter made as before mentioned is poured into the paper box until it is nearly full. The wax pattern having been oiled, and the exposed plaster of the core brushed over with soapstone powder, the whole is placed in the batter sidewise, until it is nearly half immersed, when it is removed and brushed over until the air bubbles are removed, and the plaster is in all the interstices of the pattern; it is then replaced in the batter, leaving one half of the pattern and core supports exposed. Before the plaster becomes hard, the paper-box must be removed and the plaster pierced to the pattern with a fine wire in numerous places. This mould may now be finished in the same manner as the others, except it may be necessary to warm it in some cases to remove the wax, and a large vent should be cut from each end of the core to the outside of the mould. In Fig. 4, is a transverse and longitudinal section of the mould complete.

Patterns for larger castings in iron or bronze may be very advantageously made by sweeping, or otherwise modeling the core upon which the wax is placed, using the plaster as a follow-board and the wax as a pattern. Any tendency toward sticking in the sand, may be prevented by giving the pattern a coat of shellac varnish.

The following alloys are recommended as suitable for casting in the moulds above described, and usually a number of perfect casts may be taken from a single mould:

An alloy consisting of zinc 4 parts, tin 3 parts, and bismuth 1 part, is of a light silvery color, with a brilliant crystalline surface.

Zinc 7 parts, antimony 4 parts, bismuth 1 part, make a fine light gray metal.

Antimony 1 part, tin 4 parts, make a beautiful white alloy having the appearance of silver. One or two additional parts of tin renders the metal more malleable.

These alloys all run sharp and make fine castings. They may be readily melted in a ladle in a common fire, or in small quantities over a Bunsen burner.

As to finish, the castings may be left as taken from the mould, or they may be lacquered with any of the variously colored lacquers. Or a bronze finish having the true *patina antiqua* may be given them in the following manner. Take a small roll of cotton cloth, ⅜ inch diameter, ½ inch in length, and wind a copper wire about it with several turns, finally twisting it into a handle. Dip this into commercial nitric acid and brush over the casting with the projecting end of the cotton roll.

It will be found that the acid dissolves the copper sufficiently to deposit a film on the surface of the casting. The prominent portions of the casting will be coated with metallic copper while the depressions which are not rubbed with the roll, will be coated with a bluish-green salt. Immediately, after the casting is coated, it should be washed in clean water and wiped off with a sponge, care being taken to not disturb the green deposit in the depressions of the casting. This treatment produces this effect only on the last mentioned alloy. If applied to the second one, it produces a fine dark appearance similar to oxydized silver. A further improvement may be made in the castings by warming them and brushing them over with a very slight coating of wax.

To preserve the surface of the crystalline alloy, it should be coated with a very thin film of collodion.

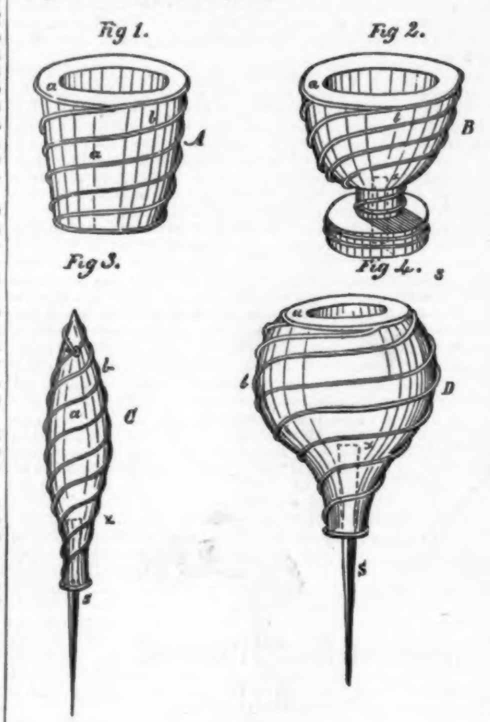
TURF FLOWER-POTS AND VASES.

By A. D. Lee, Scio, O.

Consists in a pot, vase or ornamental form made from a web of turf or grass-sod, cut into suitable outline and folded into the desired shape and tied by a cord or other wrapping material wound about it. Wild or swamp grass is preferred, because of the greater strength and tenacity of the interwoven grass-roots.

In folding the turf, I use a suitable mold to give the desired contour to the pot, etc., and to hold said web in proper position until wrapped or tied.

a is the turf or sod, and *b* the cord or wire wrapped about the pot to hold the turf in position.



The cord need not be tied at every turn, for, if it be drawn tight about the pot, it will sink slightly into the turf, and will be held firmly in place.

The pot, vase, or form, after being made as described, is filled with earth or earth-mold, in which is planted the flowers or other plants.

Such forms as shown in Fig. 3 must have a small portion of the top of turf left untied till the earth is filled into the space within, after which it is tied up to the point as shown; and, in planting in such forms, small holes are made with a suitable instrument on the top or sides for the insertion of the seed or plant-roots.

Flower-pots, etc., made according to my invention are, in themselves, a source of nourishment to the plants. They may be highly ornamented by vines or flowers planted over the outer sides.

ACTION OF AMMONIA UPON ROSANILINE.

By M. E. Jacquemin.

MM. Persoz, De Luynes, and Salvtat have shown that magenta, since named rosaniline, is capable of playing the part of a feeble acid; that it combines with ammonia to form a compound, colorless, but alterable even by an excess of the solvent, and incapable of dyeing without the intervention of an acid which displaces it and restores to it the power of combining with the textile fibre.

In 1861, resuming the study of this question after the publication of my memoir on the aniline reds, I remarked that the alteration of magenta is not immediate; that it is only produced gradually; and that a certain number of days are required for it to become complete. I have shown every year since that time in the Course of Organic Chemistry at the Higher School of Pharmacy, at Strasbourg, that it is possible to render manifest the presence of the color up to its entire transformation. It is simply requisite to steep wool, previously moistened, in the colorless ammoniacal solution, which is heated moderately, but not to the boiling-point. The curious phenomenon is then produced of a tissue which is dyed a bright red in a colorless liquid. According to Dr. Hoffman, aniline red is a compound of a colorless base and of an acid. But this acid in the commercial substance, having entered into combination with ammonia, it is not possible to admit that the wool induces the decomposition of the ammoniacal salt and the reconstitution of the red in order to combine with the latter. We are led to consider the combination of the rosaniline and the ammonia as a molecular compound which is dissociated by heat, the wool having the property of uniting with the colorless base, which abandons the ammonia, and of filling as regards it the function of an acid in producing a red compound.

Having continued the study of this question, I shall have, in my next communication, the honor of pointing out the products of the decomposing action exercised by ammonia on the different aniline colors, and of defining more precisely its first function. It will then be seen that it is not even possible to admit always a molecular combination, and that, in the case of aniline blue for instance, it is not necessary to go beyond the phenomenon of simple solution, since a skein of cotton steeped in the liquid is dyed blue by the simple process of the evaporation of the solvent in the air.—*Comptes Rendus.*